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REPORT

ON

INDIA'S FOOD CRISIS & STEPS TO MEET IT

by

THE AGRICULTURAL PRODUCTION TEAM

sponsored by

THE FORD FOUNDATION

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MINISTRY OF COMMUNITY DEVELOPMENT AND COOPERATION

April 1959

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INDIA'S FOOD CRISIS
AND
STEPS TO MEET IT

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THE FORD FOUNDATION

April 3, 1959

Shri A. P. Jain
Minister of Food and Agriculture

Shri S. K. Dey
Minister of Community Development and Cooperation

Dear Mr. Ministers:

We deeply appreciate the invitation you gave us to come to India to study, with you and your associates, India's food production problems and targets. As we have worked and studied here, and seen the magnitude of the problems ahead, we have felt a great sense of humility and profound seriousness at attempting the assignment you gave us—of helping India shape proposals for a coordinated effort to increase food production on an emergency basis. We have reached the inescapable conclusion that a rapid increase in production of food is India's primary problem in achieving human welfare, social justice and democracy over the next seven years.

The report of our findings and our proposals for emergency action, which we transmit here, reflects this conclusion and concern.

India is making steady progress in agricultural production. Since Independence, it has come far in its efforts to improve the conditions of its millions of rural people and farmers. Many important gains have been made.

We have recognized, as have India's leaders, however, the stark threat of a 28-million-ton shortfall in food-grain supplies by the end of the Third Five Year Plan (1966), unless rates of increase in food production are immediately accelerated to three times their present speed. We feel confident that such an ominous crisis can and will be prevented.

Technical descriptions of the main food production problems are set forth briefly in the report.

The findings and proposals represent the combined judgment of the Ford Foundation Team. One of our members was resident in New Delhi, the other twelve reached India January 23-25, 1959, and remained until April 4-7. Three of us had been in India before, and all have had experience in the technical review of agricultural and home science problems in countries other than our own. Each of us has had long association with agricultural production problems in the United States, and most of us worked in our own nation's mobilization to solve food problems in times of economic depression and war.

While the report is our sole responsibility as the Ford Foundation Team, we have profited by close association with Indian specialists and administrators deputed to assist us, and with the many other Indians who discussed and illumined many problems and programmes. We are grateful also for the help of other Americans working in India, especially of the resident members of The Ford Foundation, and of the Rockefeller Foundation.

We want in particular to thank Dr. Douglas Ensminger, The Ford Foundation Representative in India, for the valuable counsel and other assistance he rendered the Team in all aspects of its work.

Members of the Team were travelling during two-thirds to three-fourths of their stay in India, first as a total group, thereafter singly, or

in pairs and small groups. Every State in India was visited. In nearly each instance we were accompanied by our Indian associates. All members of the Team met and interviewed villagers, a wide variety of non-official leaders, and officers at all levels from Gram Sevak to Chief Minister in the States, and in the offices and Ministries at the Centre.

Though in India briefly, we could not have remained longer away from our normal duties in the U. S. We have tried to observe intensely and to study earnestly. At times the vastness of problems, and the almost dramatic solutions indicated, nearly threatened our objectivity.

In presenting the report, we acknowledge with deep appreciation the universal welcome we received in villages and in offices of blocks, districts and States; the continual helpfulness of our Indian colleagues; the facilities made available for travel and study; the arrangements made for interviews, visits, and conferences; and the cordial hospitality that made our experience pleasant despite the seriousness of the mission.

In aiming for brevity, we may have treated too lightly much of the excellent work we have seen. We have dwelt at length only on some of the problems that seemed to us most urgent. We have tried to be as specific as possible for clarity. Yet we realize that similar goals may be reached in different ways.

We leave India in hope and confidence that the problem of food production will receive the necessary priority throughout the Third Plan period and that India will succeed in providing food enough for its growing population—the first and basic step, we believe, in achieving India's goal of social justice.

Sincerely,

Sherman E. Johnson

Dr. Sherman E. Johnson (Chairman)

Marvin A. Anderson

Dr. Marvin A. Anderson

George M. Beal

Dr. George M. Beal

E. M. Cralley

Dr. E.M. Cralley

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THE CRUCIAL DECISIONS

This is a report on India's food crisis. It reaches the inescapable conclusion that an immediate and drastic increase in food production is India's primary problem of the next seven years. It points out that without food enough, India's hopes for improving human welfare, achieving social justice, and securing democracy will become almost impossible of attainment.

The report has been prepared by an American team of agricultural specialists brought to India at the request of the Ministry of Food and Agriculture and the Ministry of Community Development and Cooperation, with the sponsorship of The Ford Foundation.

Naturally, many aspects of India's agricultural problems differ greatly from those of the U.S. But solutions lie in the common experience of world agricultural development. It was in this context, and with full regard for India's present resources and its potential development, that the Team approached its serious assignment.

Within the time allotted, the Team made every effort to study Indian food production problems carefully and thoroughly. Members of the Team travelled extensively in all the States of India, interviewed Government officials at all levels, village cultivators and other private citizens, and studied, wherever possible, such relevant statistics, documents and memoranda as were made available. The findings and conclusions of the Team are contained in the three parts of the report which follow.

Not only in its travels, but in every step of its inquiries and discussions, the Team had the able assistance of Indian associates deputed to work closely and continuously with the Team. With the help of these associates and of discussions with Indian leaders, the Team, in studying food production problems, bore constantly in mind the broad range of Indian objectives for industry, employment and general economic development and the relationship of agriculture to them.

As the report itself repeatedly emphasizes, there are no simple solutions to India's food production problems. No two or three easy steps can be taken to allay the impending crisis.

The facts and analyses which lie behind the Team's conclusions are found in the body of the report. But as the Team discussed its findings, with its own members, with its Indian associates, and with Indian leaders, certain crucial issues, certain major proposals stood out above all others for immediate attention and action.

1. **The Third Plan Target:** *A Third Plan target of 110 million tons of food grains by 1965-66 is reasonable,* in view of India's rapidly rising population. Eighty million more people, or a total population of about 480 millions, are expected by the end of the Third Plan. A 110-million-ton target is needed to provide food enough for the added millions, and to provide for some dietary improvement and a safety margin for poor crop years and emergency conditions.

2. **The Impending Gap:** India is making steady progress in increasing food production, but the rate of increase must be tripled, to meet the Third Plan target. If India's food production increases no faster than present rates, *the gap between supplies and target will be*

28 million tons by 1965-66. This will be about 25 per cent shortfall in terms of need. *No conceivable programme of imports or rationing can meet a crisis of this magnitude.*

3. **The Need for Emergency Action:** A Third Plan target of 110 million tons of domestic production can be achieved. The best in Indian agriculture is comparable to the best in other countries. The task is to develop ways of raising the low average to the highest levels which some Indian cultivators have achieved.

A 110-million-ton target, however, can be realized only if an all-out emergency food production programme is undertaken. Food production must be given the highest priority. It must have the sponsorship of topmost leaders who can and will mobilize the nation for action to meet the impending crisis.

4. **The Need for Stabilization of Farm Prices:** Unless the cultivators is assured of a floor price for his food grains, he will be unwilling to invest in fertilizer, better implements, improved seed and other expenses necessary to increase production.

Recommended incentives for increased production are:

(a) A guaranteed minimum price announced in advance of the planting season.

(b) A market within bullock-cart distance that will pay the guaranteed price when the cultivator has to sell.

(c) Suitable local storage. *Immediate consideration should be given to using funds available from grain imports under PL 480 and other special programmes to construct needed godowns in village areas.*

5. **A Public Works Programme for Increasing Food Production and Village Employment:** The unemployed and underemployed in the villages represent a waste of resources that should be used to produce more food. Moreover, about 45 million of the 80 million increase in population will be rural people. The Team recommends *a public works programme for projects requiring primarily hand labour, such as contour bunding, land levelling, surface drainage, irrigation wells and tanks.* Such work will contribute directly to increasing food production, provide income for needy people, and will not be inflationary.

6. **Priorities for Chemical Fertilizers:** Fuller use of manures, composts, and green manures is commended. But at the very best, these can substitute for only a small fraction of the chemical fertilizers needed to meet Third Plan food targets. Only with more abundant chemical fertilizers will benefits from irrigation, bunding, improved seeds, and other facilities be realized.

The targets for fertilizers to be made available for the end of the Third Plan, developed in the Ministry of Food and Agriculture, are soundly based but conservative in relation to need. These amount to 1,500,000 tons of nitrogen, 750,000 tons of phosphoric acid, and 200,000 tons of potash. *Even though conservative, they mean a 9-fold increase in use of nitrogen and considerably larger increases of the others, the use of which has just started.*

Hence the Team recommends that *procurement of fertilizers and means of producing high-analysis fertilizers be given a top priority, including foreign exchange as necessary.*

7. **Intensified Irrigation and Drainage Programmes:** India is using only a small portion of its potential water supply, which is one of the largest in the world. India now gets only one-fifth to one-fourth ton increase in crop yields on irrigated lands as compared to non-irrigated lands. Moreover, only about 12 per cent of irrigated acreage grows more than one irrigated crop per year. India cannot afford this waste of resources. Better water management is needed.

The Team believes that *India can make greater and more immediate gains in food production by intensifying expenditure of time and effort on water management than by constructing large-scale irrigation projects* which take years to develop. The Team recommends that the Third Plan allocate substantial funds for technical assistance to aid cultivators in making better use of available water. Provision must also be made for a more comprehensive approach with coordination of all relevant departments. The Team also recommends that more emphasis be placed on irrigation projects which will yield rapid returns in food production, such as tube wells and shallow masonry wells.

Millions of acres could be reclaimed and made more productive by drainage improvement. The Team recommends that *drainage improvement be given a high priority, and believes that a unified agency is necessary in each State for coordination and improvement of drainage.*

8. **Selection of Certain Crops and Certain Areas for More Intensive Efforts:** There are tremendous physical potentialities for increasing production per acre if they can be achieved. There are no inherent soil, climatic or other physical reasons for the present low yields. But there are no blanket proposals that can be generally applied to reach the Third Plan target. *The Team recommends that those selected crops and those selected areas in each State should be chosen which have the greatest increase potentialities.*

Efforts to stimulate food production should be directed more heavily to *rice* and *wheat,* which now make up more than half of total food grains. With hybrid maize, India can in 5 to 7 years make more progress in increasing yields than the U.S.A. made in 20 years.

More effort should be concentrated on the most promising areas for wheat and rice production, i.e., those which have had the most rapid rate of increase in the recent past, and which have also the highest potential for rapid large increases in the years immediately ahead. For rice, there are 25 important growing districts; for wheat, there are selected districts in the Punjab, U.P., M.P. and Bihar.

These areas will, the Team believes, increase India's food production more rapidly than others, if given allocation of fertilizers in combination with other improved practices, such as plant protection measures, improved seeds, and water for irrigation. Attention to other areas should not be reduced. But, in the national interest, the Team believes that increased effort should be immediately directed to the most responsive areas.

9. **Security of Land Tenure and Land Consolidation:** Assurance of stability of tenure can contribute substantially to food production. The Team's recommendation is that land ceilings and other land reforms should be settled as quickly as possible, and stay settled for the Third Plan. Firm plans should be developed immediately to schedule the completion of consolidation of fragmented holdings, village by village, as soon as possible. Improved coordination must be provided. In some Indian villages, consolidation has been carried out in ways to increase production greatly; in others, it has not, because of inadequate coordination with those responsible for planning water control structures and boundaries of holdings.

10. **Immediate Large-Scale Credit Through Cooperatives:** The present marketing, supply and credit services are major deterrents to increasing food production Eighty-five per cent of credit is now supplied by money lenders and other individuals. Most marketed grains are sold to local traders at harvest time at depressed prices. Strong cooperatives can break these bonds.

> To help cooperatives do so effectively, the Team's major recommendations are that (1) Government must be prepared to provide loans and to assist in developing capable management; and (2) standards of credit worthiness must be redefined to encourage production loans on the basis of expected crop yields and repayment ability, instead of land security.

11. **Progressive Reduction of Cattle Numbers:** The excessive animal population competes with people for the products of the land. The Team recognizes the limitations imposed by beliefs concerning cattle slaughter. Other ways of dealing with the problem are possible.

> The Team recommends that legislation be considered providing for: (1) a tax policy which makes maintenance of useless cattle a burden on their owners (tax receipts could go to villages for improvements); (2) confinement of all bulls and mandatory castration of all bulls not kept for breeding; (3) measures to control open grazing; (4) establishment of dessicating plants to process fallen animals, with incentive payments to owners who bring in fallen cattle.

12. **The Urgency of a High-Level Coordinating Food Production Authority:** Far-reaching centralized authority with a clear line of command and execution alone can meet the challenge of growing more food. The Team believes that such authority is essential to allocate resources on a priority basis—such as personnel, fertilizers, steel (for sprayers, godowns, fertilizer plants, etc.); to coordinate irrigation, drainage and soil management programmes; and to enforce policy decisions giving priority to food production. The administrative structure, moreover, must be simplified and clear lines of authority and responsibility established at all levels of Government, so that policy decisions are carried out to the village level.

13. **The Role of Community Development and the Technical Ministries:** Community Development and all technical agencies must be geared to mobilization and strengthening of village leaders and organizations, and effective channelling to village people of all information and help necessary to increase food output. The Team believes, therefore, that *all Ministries concerned with any aspect or programme*

relevant to food production must give top priority to food production now and for the period of the Third Plan.

14. **India's Capacity to do the Job:** While the Team has been concerned with India's problems and has highlighted the critical issues, *the Team leaves India confident that it is within the capacity of India's people to mobilize to meet the great crisis before them.*

PART ONE

THE NEED FOR EMERGENCY MEASURES

THE NEED FOR EMERGENCY MEASURES

1. THE GAP IN FOOD PRODUCTION

India is facing a crisis in food production. More specifically, it is a crisis in *food-grain production* because food grains comprise two-thirds of the caloric intake of the average Indian. The crux of the problem is food enough for the rapidly increasing population.

Five million persons per year were added during the First Five Year Plan, and seven million per year will have been added during the Second Plan Period. Ten million per year probably will be added during the period of the Third Plan ending 1966. Although there is considerable emphasis on family planning in India, no appreciable slowing down of population growth may be expected during the Third Plan period.

This means that food will have to be provided for 80 million more people by the end of the Third Plan. This explosive increase in population will raise the total from 360 million in 1951 to an estimated 480 million by 1966.

Can food production be increased sufficiently to feed the added millions and to provide a margin of safety for poor crop years? This is the crucial question. Substantial expansion of food-grain production is necessary even to maintain existing consumption levels, which are among the lowest in the world. The present population places severe pressure on food supplies, and unfavourable crop conditions create an immediate crisis.

The Impending Shortage

The entire nation must be made aware of the impending food crisis and steps must be taken to meet it. Adequate supplies of food may indeed be essential to survival of democracy, because freedom from hunger is a prerequisite to enjoyment of other freedoms. *If elementary wants, such as food and clothing, are not satisfied, other freedoms may be sacrified for the promise of food enough.*

The extent of the impending food-grain shortage is indicated clearly in the accompanying chart (page 15). The successive Five Year Plans have included food-grain production targets as major components. Starting from a base of 58 million tons of food grains in 1949-50,* the First Plan set a target of 65.5 million tons by 1955-56. This target was achieved quite easily as a result of greater emphasis on agricultural production, and with the help of favourable weather.

The Second Five Year Plan set a target of 80.5 million tons of food grains by 1960-61. But the annual crop returns are less than the target rates. The Report of the Foodgrains Enquiry Committee in 1957 summarized the prospects of reaching the target:

> "Most of the State Governments told us that not more than 60 per cent of the revised targets under the Second Plan will actually be achieved."

* Adjusted figures.

Food grain production in 1958-59 is estimated at 70 million tons, but growing conditions have been very favourable.

Preliminary planning is now under way for the Third Plan. No specific targets have been announced, but discussions indicate that *from 100 to 110 million tons of food grains will be required by 1965-66.* This assumes that population will continue to increase at projected rates, and that a small rise will continue to take place in per capita consumption of food grains.

A target of 100 million tons would permit a net daily consumption per person of 15 ounces of cereals and 3 ounces of pulses for the prospective population. This compares with the consumption in 1956-57 of 13.3 ounces of cereals and 2.4 ounces of pulses. A target at this level, therefore, would allow for some improvement in the diets of those who are now at bare subsistence levels, but it would not provide a safety margin for adverse weather nor for reserve stocks needed to stabilize prices and to meet other unforeseen emergencies. A target of 110 million tons is necessary to allow for these contingencies.*

In addition to food-grain production, any balanced agricultural programme should provide also for additional production of dairy and poultry products, fruits and vegetables to meet the demands of an expanding urban population and to permit gradual improvement in diets.

But the conclusion is clear: *the gap between needs for food grains, as indicated by the Plan targets, and supply, as indicated by production trends, is growing wider, as shown in the chart, page 15.* The relatively favourable 1958-59 season failed to reach the annual average of the food-grain target by 4.3 million tons, and the 1957-58 crop was 9.3 million tons short. *If food-grain production increases no faster than indicated by the present trend, the gap between supply and needs in 1965-66 will be about 28 million tons.*

In order to produce 110 million tons of food grains annually by the end of the Third Plan, the rate of production increase must average 8.2 per cent per year for the next 7 years. This rate of increase compares with an annual average of 2.3 per cent from 1949-50 to 1958-59, and an average of 3.2 per cent from 1952-53 to 1958-59. The

* Estimates of future food-grain needs are complicated by the necessity for making assumptions regarding trends in population and levels of consumption. We estimated requirements for cereals and pulses in 1965-66 for a population of 480 million persons on the basis of daily net consumption of 15 ounces of cereals and 3 ounces of pulses or a total of 18 ounces. Food grains amounting to 12½ per cent of total production are required for seed, livestock feed and wastage. Also, an additional 9.4 million tons is allowed for stock requirements, and as a safety margin for adverse weather and other emergency conditions. The total is derived as follows:

Consumption requirements for cereals and pulses ...	88.0 million tons
Seed, feed and wastage (12½ per cent of total production)	12.6 million tons
Stock requirements and safety margin	9.4 million tons
Total needs	110.0 million tons

task is overwhelming. The urgency of an all-out effort is obvious. Adequate resources must be made available to accomplish the job.

It is clear that the necessity for conserving foreign exchange requires holding imports of food grains to a minimum level, except as imports become available under special exchange programmes. *In any case, no conceivable programme of imports or rationing could meet a crisis of this magnitude.*

A Third Plan *target of 110 million tons must be reached if the country is to go forward on its development programme.* In fact greatly accelerated expansion of food production is necessary to prevent hunger and possible civil disturbance.

This target can be achieved if an all-out emergency food production programme is undertaken. The best in Indian agriculture is comparable to the best in other countries, but the average level is unduly low. The task before the country is to develop ways of raising the low average to the higher levels that many Indian cultivators have achieved.

Top Priority for Food Production

Many leaders and administrators are aware of the critical importance of increasing production. Others, unfortunately, have an air of complacency not warranted by the facts. Some, in surplus production areas, prefer the high prices associated with lower production, and consider Plan targets unrealistic and unnecessary.

It is clear to us that food production increases at the rate required to reach a 110-million-ton target cannot be realized unless an all-out emergency programme is undertaken, and adequate resources are made available. This means that agricultural development must be given the highest priority among all the categories of development for the remainder of the Second Five Year Plan and for the entire Third Plan period.

The needed high-priority status can be achieved only through sponsorship by top leaders of the nation and the States. They must take the steps necessary to ensure that adequate resources are made available. Of equal importance is the need to inspire all those engaged in agricultural work to develop and to carry out programmes that reach the villages and individual cultivators. All the villagers, including the women and youth, must have an opportunity to contribute to such a programme. They must be motivated to accept the challenge of increased food production in their own interests, and also as their contribution to national welfare.

The availability of more food can, at least partially, offset inflationary tendencies in the national development programme. During the period of building industrial plants, workers are employed in construction, and, therefore, purchasing power is created ahead of offsetting increases in the production of consumer goods. This creates inflationary pressure and prices rise. But such a large portion of consumer expenditures goes for food that inflationary tendencies in other sectors of the economy will largely be offset if more food becomes available.

The statement has been made by Indian leaders that if the food problem is to be solved, the work must be placed on a "war footing." We concur in the view, *and we suggest that "food enough" become a central objective in the crusade for the new India visualized by its leaders.*

But an effective crusade involves more than plans. It requires allocation of the necessary resources, and hard work, zeal, enthusiasm and sacrifice on the part of all those who are engaged in it. Good planning is meaningless without adequate execution of the plans that are made. *"Business as usual" will not achieve the food production targets. The steps necessary to mobilize the nation for action must be clearly outlined.*

Table 1

India's Production of Food Grains

(Adjusted on the basis of 1956-57 final estimates)

(million tons)

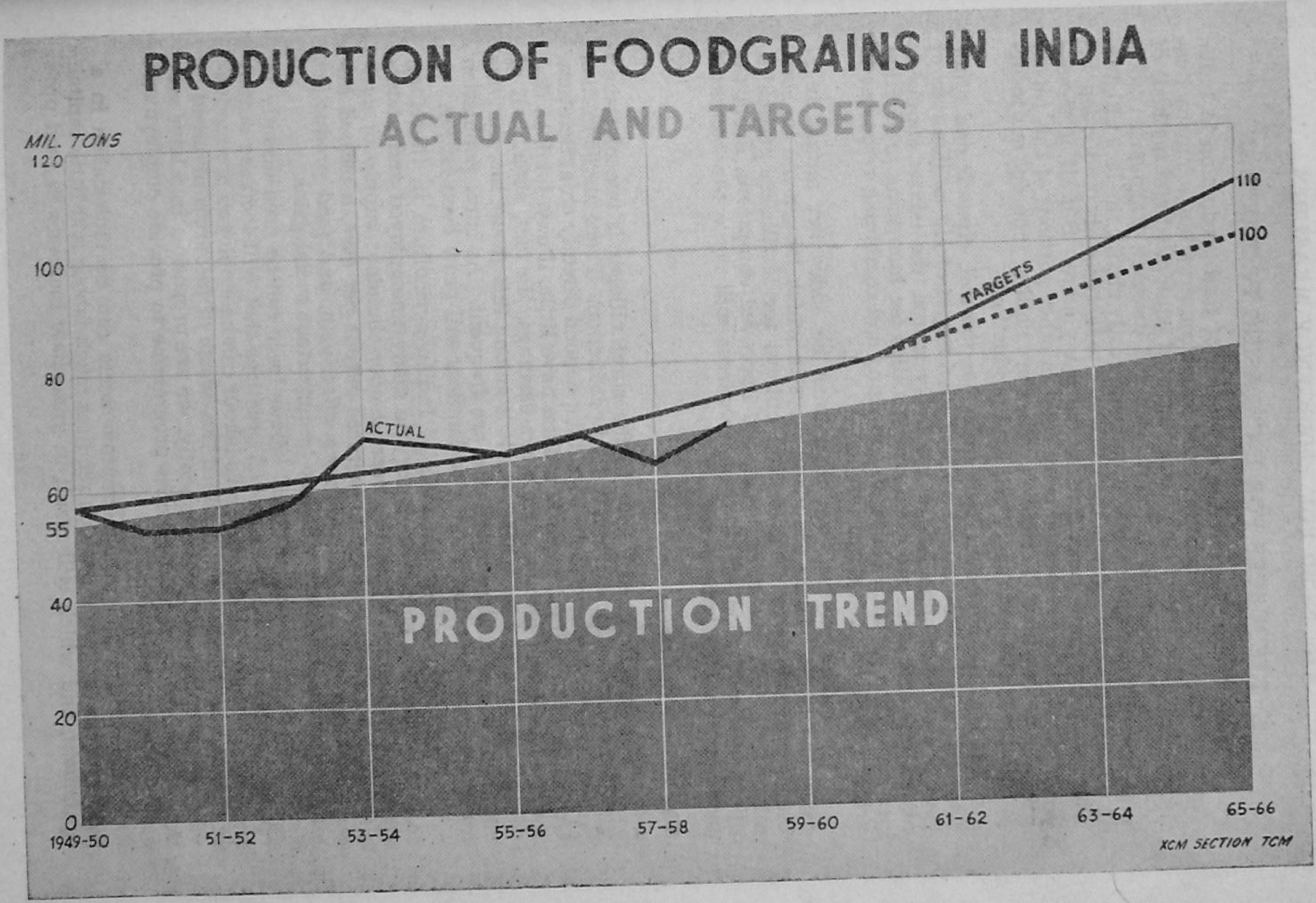
Year	Rice	Wheat	Other cereals	Total cereals	Total pulses	Total Food grains
1949-50	23.8	6.6	18.0	48.4	9.5	57.9
1950-51	21.0	6.6	16.1	43.7	8.7	52.4
1951-52	21.5	6.2	16.6	44.3	8.6	52.9
1952-53	23.1	7.4	19.0	49.5	9.3	58.8
1953-54	28.3	7.9	22.1	58.3	10.6	68.9
1954-55	25.1	8.8	22.2	56.1	11.0	67.1
1955-56	26.9	8.6	19.0	54.5	10.8	65.3
1956-57	28.1	9.1	20.1	57.3	11.4	68.7
1957-58	24.8	7.7	20.3	52.8	9.2	62.0
1958-59	29.7	10.0	..	..	..	[1]/70.0
1960-61	..	..	..	..	..	[2]/75.0
1965-66	..	..	..	..	..	[3]/80.5
			..	..	..	[4]/110.0

Table 2

Targets of Food-Grain Production in the 1st, 2nd and 3rd Five Year Plans

Year	Production target (mil. tons)
1949-50 (Base year of the First Plan)	57.9
1955-56 (End year of the First Plan)	65.5
1960-61 (End year of the Second Plan)	80.5
1965-66 (End year of the Third Plan)	[4] (110.0 (100.0

1/ Preliminary Estimate. 2/ Anticipated. 3/ Target. 4/ Target under discussion.


PRODUCTION OF FOODGRAINS IN INDIA
ACTUAL AND TARGETS
MIL. TONS
120
100
80
60
55
40
20
0
1949-50
51-52
53-54
55-56
57-58
59-60
61-62
63-64
65-66
ACTUAL
TARGETS
110
100
PRODUCTION TREND
XCM SECTION TCM

THE NEED FOR EMERGENCY MEASURES

2. RESOURCES FOR INCREASING PRODUCTION

Many factors impede the expansion of food production in India. Among these are inadequate soil and water conservation, too many livestock for available feed supplies, antiquated equipment and methods of cultivation, a multitude of plant pests and diseases, fragmented holdings, insecurity of tenure, inadequate and costly credit, the lack of effective incentives to encourage the cultivator to increase his production, inadequate programme coordination, and many more. But all of these—many of which are discussed more fully in other portions of this report—can be dealt with and removed. They are neither inherent nor insurmountable obstacles to increased food production.

It is clear, moreover, that *India has the soil, climatic and other physical resources to achieve a Third Plan target of 110 million tons of food grains.* Although land is relatively scarce, the labour supply is abundant, and there are great potentialities for increasing production per acre. The problem is one of organizing and combining resources to achieve the food production targets.

To India's physical resources must be added her human ingenuity and effort. There are many ways in which labour can be combined with relatively small capital outlays for fertilizers, pesticides, minor irrigation works, drainage, and improved equipment. *From the effective combination of all these resources will come the increased food supply which India needs.*

The Labour Resources

The underutilized labour in the rural villages is one of India's greatest resources for increasing food production. There are 65 million rural families, of whom about 50 million depend directly on agriculture. Out of these 50 million, some 20 million have little, if any, land, so that they must depend primarily on wage earnings. In fact, about half of this group have no land whatever. It is among this group, too, that unemployment and underemployment are frequent. As rural population increases, moreover, the number of landless will grow even larger.

One of the major problems of Indian agriculture is, therefore, to find productive employment for the many unemployed and underemployed villagers. *If India's present over-abundant supply of agricultural labour can be used to increase output per acre, a wasted human resource will be utilized more effectively, and food production will be increased.* There will also be important social gains.

A part of the underutilized labour force can be used directly to apply the combination of improved practices that will increase output per acre. But not all of the surplus labour can be employed productively this way and India cannot afford the waste of resources involved in village unemployment. Consequently, we are proposing, in a later section of this report, a public works programme to provide employment and to produce more food.

Many land and village improvements can be undertaken in a public works programme which requires much labour and little capital equipment, and which will result in immediate increases in food pro-

duction. Among these improvements are building of contour bunds and other soil and water conservation structures, land levelling, some drainage work, masonry wells and tanks for irrigation, village godowns, and even village-to-market roads.

Capital Resources Required

But labour alone will not accomplish the task. *Sufficient capital must also be provided to permit the most effective use of the abundant labour resources.* Chemical fertilizers, pesticides, improved seeds, and other materials will have to be made available in adequate quantitities. Investments will have to be made in fertilizer plants, in tube wells and other minor irrigation works, and in some other facilities related to food production. In this connection, it is important to note that the *ratio of capital expenditure to added output will be much less in food production than in most other enterprises, and that the increase in output will generally come more quickly from investments in food production than from investments in heavy industry or very large irrigation projects.* Such increases in output consequently will counteract inflationary tendencies from the increased expenditures.

Lack of Knowledge a Limiting Factor

Even when the land resources, the labour and the capital are available, increased food production may not follow because lack of knowledge is a major limiting factor. *Most of the improvements needed to double yields are already known to some people. Many improved practices have been adopted by some cultivators, in some areas. But until this knowledge is more widespread and acted upon, food production targets cannot be achieved.*

The dimensions of this problem are suggested by India's present low average yield per acre—among the lowest in the world. Yet it is also clear that this situation is due to no inherent physical or climatic limitations. Moreover, although yields in some areas have increased in recent years, and total agricultural production has expanded, average yields have not changed significantly. For example, the average yield of rice per acre in India is about one-third that of Japan, although some growers achieve yields equal to those of Japan. The yields per acre of wheat and other food grains are correspondingly low in comparison with other grain-producing countries.

If the known improvements that are adapted to each area were generally adopted in their most effective combinations, food production targets could be attained. But physical potentialities and the steps necessary to their attainment must be distinguished. And it is in this connection that lack of knowledge is crucial. Lack of knowledge exists not only among the cultivators, but also among those who work with them. Thus, training and the dissemination of knowledge are of tremendous importance for better use of India's food production resources.

Combined Practices Required

The evidence is clear that startling increases in food production are possible if the known improvements are adopted in effective combinations.

A few improved practices can be effective if adopted singly, but the full benefit from most improvements can be obtained *only* if they are adopted in combinations suitable for specific soil and climatic conditions. Sufficient fertilizers, improved seed, pesticides, proper soil and water management practices—all of these, while important in themselves, can be *fully effective only if adopted in combination with each other*. For this reason, improvement programmes should be designed to concentrate on the adoption of those *combinations of practices* that are most likely to increase food production quickly.

Tailor-Made Programmes

Equally important, improvement programmes should be tailored to fit the conditions faced by individual cultivators, village by village, block by block and area by area. It is obviously impossible for agricultural workers to give individual assistance to all the cultivators in India, but a uniform, blanket approach should be avoided. A nation-wide improvement programme should be developed which will concentrate on the combination of practices that are most likely to increase food production quickly in the different areas.

The major improvements selected for special attention in each district and block must be those which are the limiting factors in increasing production. For example, the Japanese method of paddy cultivation is not suitable for general adoption, but where it is applicable it does represent a combination of practices. The experience in Bombay State indicates, however, that credit and adequate professional assistance are necessary for full success. Specific obstacles to adoption must be faced and overcome. The cultivator must have assurance that he can market his crop at prices that more than pay for the extra expenses incurred, and must have timely credit available at reasonable rates in order to undertake the added expenses involved in the new venture.

Before an improvement programme is undertaken in an area, it would be desirable to estimate the costs and returns for some typical farm situations in order to determine the potential effects on the net incomes of the cultivators. This could be done by simplified budget methods, and would greatly aid village and other extension workers in convincing cultivators of the value of improved practices.

Rice and wheat are India's major food crops. Improvement programmes, therefore, will need to emphasize the areas and the cropping systems with the greatest increase potentialities for these crops. Other cereals and pulses are extremely important, especially in some areas, but their production is less than that of rice and wheat. Although priority will have to be given to the potentially most productive areas, special programmes also should be developed for other areas. Some can be made more productive by undertaking suitable land improvement programmes. Non-farm employment also should be developed to the greatest possible extent to help these areas solve their problems of unemployment.

It is apparent that research, education and other programmes, and a coordinated approach to the job, are a part of the resources that are necessary for the task ahead. *There are no panaceas. There is no set of three or four simple measures that can be generally applied*

to reach the goal. India is a large country and no blanket programme can fit all areas and situations.

Basic Premises

In suggesting ways of coping with India's food crisis, we have, therefore, made the following assumptions:

1. Programmes to increase food-grain production will receive the funds that are required for such items as credit, fertilizer, seed, soil and water conservation including irrigation and drainage, other land development, plant protection, food storage and processing facilities.
2. Adequate personnel will be trained and assigned to the job of increasing food production.
3. At all levels top leadership will be provided and coordination will be achieved among planners, administrators, educators, natural scientists, social scientists, local community leaders and cultivators. Without such leadership and coordination, no production programme can be successful.
4. Efforts will be concentrated where results will be greatest.
5. Since most of the risks associated with programmes to increase food production fall on the cultivators, they will be protected from price declines that would discourage expanding of production, and steps will be taken to stabilize food supplies and and prices over time and space.

If the abundant labour supply is used effectively, along with the necessary materials and capital equipment, if credit is supplied as needed, if the applicable knowledge is made available, if combinations of practices are adopted that are suitable to each area, then, it seems to us that India can achieve the necessary food production targets. *We firmly believed that, eventually, production per acre could be doubled* by helping cultivators see the possibility of betterment, by demonstrating the specific steps necessary for reaping the full benefits, by providing the incentives to adopt known improvements, and by helping cultivators overcome the obstacles in the path of achievement.

THE NEED FOR EMERGENCY MEASURES

3. ORGANIZING TO MEET THE CRISIS

We are convinced that extraordinary organizational and administrative measures and actions are required to mobilize the nation to meet the challenge of producing food enough to meet minimum requirements of a rapidly growing population.

Many separate agencies have more or less direct interests in various aspects of food production. Their programmes and activities are diverse and at times seek different and not always consistent goals. Coordination is not always good. Conflicts in purposes, in methods, in emphasis, are not uncommon. Divided and diluted responsibility among agencies concerned with food production creates an environment in which inaction and delay are accepted as normal, and where assumption of leadership and initiative is discouraged.

To deal effectively with the food crisis, we believe that powerful emergency organs of Government having unquestioned and unfettered authority to act are necessary.

In view of our unfamiliarity with the Indian administrative system, we cannot outline the detailed steps that need to be taken, but we do wish to suggest the types of action that seem to be required, so as to indicate more clearly why present arrangements are not adequate for the job.

We believe that *the crisis in food requires action at the highest levels of Government. But there must be follow-through at all levels.* Legislative as well as administrative branches of Government must be aware of the urgency of the situation. *Decisions which are binding on all Ministries of Government and on all levels of Government, and which are supported by political leaders, must be made.* The crucial role of agriculture must be recognized and the best technical knowledge on food production must be brought to bear on the problems without equivocation or delay.*

Power must be granted to set priorities among activities, including the reallocation of budgeted funds and foreign exchange in the interest of greater food production. Power must also be granted to reallocate and reassign personnel, to redefine programme content and emphasis, including the power to stop on-going programmes and activities which conflict with or detract from immediate food production activities. Finally, power must be granted to require coordination and collaboration among Government agencies to simplify administrative, fiscal and other procedures as necessary to win the battle of food production.

There are undoubtedly several ways in which these administrative problems might be handled. One might be to increase the responsibility and authority of the Ministry of Food and Agriculture and to hold this Ministry solely accountable for meeting the crisis. Another might be to revitalize and broaden the powers and functions of existing cabinet committees dealing with this subject. We are not so concerned

* Other portions of this report present detailed recommendations on administrative and technical aspects of a food production programme.

with the details of how the problem is dealt with, but with the effectiveness of what is done. Mere paper organization will not do the job. Advisory committees, consultative and coordinative bodies, or discussion groups are not enough. *Far-reaching, centralized authority with a clear line of command and execution, alone can meet the challenge of growing more food.*

It is clear to us, too, *that the urgency of the problem and the need for clear-cut organizational adjustments to meet it must be understood at the State level.* Unless State officials recognize the crisis and the need for forceful and direct action, the problem cannot be solved. We emphasize that existing policy conflicts between departments, the present lack of coordinated efforts on food production, and the frequent failure to provide adequate funds for agricultural work must be eliminated.

The organization problem does not stop at the State level. *Appropriate changes, redirecting efforts at district, block, and village level, must also occur.** It would seem desirable at the district level, for example, that an officer with the status of the collector, having a knowledge of agriculture and fully cognizant of the seriousness of the food crisis, be given responsibility and authority to direct and implement policies and programmes for increasing food production. He should have full authority, supported by decisions at the State level, to reshape block programmes as needed to attain the best use of block resources in meeting food production goals. This means, of course, that he must have the responsibility and authority to coordinate the activities of all departments and agencies operating at the district level in so far as their activities can contribute to increased food production.

We have elsewhere in this report suggested the placement of additional specialized agricultural officers. Training programmes must be stepped up to permit more adequate staffing as rapidly as possible. *As competent personnel become available for such staffing, they should first be assigned to those areas and blocks where the combination of water, soil, and other resources indicate that food production increases will be greatest.*

We have also proposed a reassignment of duties and responsibilities of block staff and a readjustment of block programmes and budgets to more nearly reflect the food production crisis and the potentialities of particular blocks. It is clear that these readjustments can only be effective if fully supported by policy, programme, and administrative decisions at district and State levels. General resolutions to the effect that VLWs are to devote 70 per cent to 80 per cent of their time to agriculture, for example, cannot be effective unless and until time allocations and programme emphasis at all levels above the VLW are similarly changed. Efforts should be directed to basic and enduring programmes, rather than to hastily designed campaigns. And such programmes must be effectively implemented. And as the programme goes ahead, careful programme research and evaluation should be undertaken to permit sound adjustments and changes.**

We would like to emphasize that at each level, agencies and *officers should be given well-defined, manageable and inescapable re-*

* Some of these changes are suggested in subsequent parts of the Report.

** This need is considered more fully in Part III, Chapter XIV.

sponsibility with full authority to discharge that responsibility. They should be judged by their initiative, their ability to push through the programme, and by their concrete accomplishments in increasing food production.

India faces a crisis of overwhelming gravity, and the administrative structure must positively be simplified and tightened to meet this crisis.

PART TWO

ACTION HIGHLIGHTS

ENABLING VILLAGE FARMERS TO INCREASE PRODUCTION

CHAPTER I — BETTER ECONOMIC AND ADMINISTRATIVE ARRANGEMENTS

1. PRICE STABILIZATION

Indian farmers have experienced wide fluctuations in food-grain prices during the independence period. These fluctuations have brought hardship both to producers and consumers.

Accompanying the extreme year-to-year price fluctuations in food grains have been comparable or even greater differentials in the prices of the same commodity at the same time in different markets in India. Some of these variations can be justified by the costs of moving the commodity from one place to another. Others result from quality differences. Even with these qualifications, the price disparities have been unreasonable.

But the major price difficulty experienced by the cultivator is the tendency for prices to be low immediately after harvest, which is the time when he must sell to meet his obligations. Then subsequently a rise in prices usually occurs which affects him if he buys food grains for home consumption or for seed. Some seasonal rise in price after harvest is necessary to cover the costs of storage and risk of quality deterioration.

Customarily, however, the fall in price at harvest time (relative to its later increase) is greater than is warranted by service costs alone and represents the weakness in bargaining power of the cultivator and his inability to retain possession of the harvested crops.

Price uncertainties are especially troublesome to the many cultivators who go into debt for crop expenses, and frequently for capital items such as purchase of bullocks. As a result they hesitate to incur added operating expenses and new investment for expanding production because they are worried that the increased outlay will not be covered by sale of the additional produce. They fear that the price will drop to levels that will reduce rather than increase their net incomes. The price uncertainties of recent years have been especially serious for small cultivators. They cannot afford to take the risks involved in wide price fluctuations.

The results of these extreme price fluctuations for food grains by years, by locations, and by seasons of the year are undesirable not only to cultivators, but to other major groups in the Indian economy and to the Government itself. The need for price stabilization arises out of concern for these various interests which are detrimentally affected by recurrent and extreme changes in prices. An increase in prices brings immediate hardship to consumers who tend under all circumstances to spend a high proportion of their incomes on food grains. Economic pressure and even famine follow closely on substantial price increases. All groups prefer a relatively stable level of prices, but this cannot be achieved with the present marketing and price structures.

To encourage increases in food-grain production, the cultivator should be assured of a price which will enable him to invest in fertilizer, seed and new equipment knowing that, with average crop conditions, he can repay any debts with the added income that results from adoption of improved practices. Such assurance would constitute an important incentive to increased production.

Suggested Approaches to Price Stabilization of Food Grains

A conscious and consistent price policy is necessary to guide production to planned targets. This policy should aim not merely at reducing price variations but should maintain relative positions among agricultural commodities to attain desired patterns of output. Special price inducements or deterrents should encourage or discourage the use of agricultural resources for particular purposes. It is recognized that the erratic nature of production prevents exact response in the short run; flexibility, therefore, is required to meet changing supply situations.

Indian experiments with price control in recent years have been aimed at checking excessive price rises or falls rather than achieving any continuing price stability. These temporary programmes of expediency fail to protect adequately the interests of either producer or consumer. They lead to speculative activities and do not provide the proper basis for the planned progress which is fundamental to growth.

The specific assurances required by the cultivator as incentives for increased production are:

(1) A guaranteed minimum price publicized in advance of the planting season.

(2) A market that is ready to accept his crops at the floor price at the time he wants to sell.

(3) Availability of this market within bullock-cart hauling distance.

(4) Suitable local storage for the portion of the crops which he does not wish to sell at harvest time.

The major need for price stabilization is a systematic and continuous effort to maintain food-grain prices at the desired level. This can be accomplished only by a permanent agency which can formulate price policy and implement this policy with the required action.

We suggest that such an agency be given the responsibility for:

(1) determining base prices and the permissible range in variations from these prices,

(2) announcing the prices well in advance of the sowing season,

(3) initiating purchase or sales operations as required by circumstances,

(4) establishing the locations for stocks of each food grain and the recommended supplies to keep in reserve,

(5) determining export and import duties and quotas and such other devices for controlling prices as may be necessary,

(6) encouraging the development of an effective grading system.*

Determining the Guaranteed Price

The level of minimum prices must be set with great care after consideration of all pertinent factors. Ideally the price guarantee for a specific product should protect the cultivator against unduly low prices and risk of loss. It should also even out seasonal fluctuations

* The need for and problems of grading are discussed more fully in Part III, Chapter III.

by holding prices up during the harvest season and should clear the market over the entire season, except for the quantity retained by the Government for buffer-stock operations.

If the price is set too high, it may cause hardship for consumers. It might also bring restrictions on imports to protect the domestic market. On the other hand, if the price for any food grain is set too low, the required production and marketing may not take place, and expensive procurement and rationing programmes would have to be established, especially following a poor crop season. The floor prices to producers must be set with due regard for the best interests of the economy as a whole.

The price must also not be set so high that price supports will become a drain on the national treasury. No large or sustained transfer payments between the agricultural and other sectors of the economy are feasible.

It is apparent that the level of price guarantees will need to be established on the basis of the best possible estimates of domestic and world supply of food grains, and on the basis of import prices as well as estimated domestic demand. It seems doubtful that a rigid formula can be developed which can be followed from year to year. Estimates will need to be made concerning prices for different food grains that are likely to clear the market. Then the price guarantees to farmers will have to be established with due regard for competition with other crops, for necessary handling margins and for fluctuations in production.

The data required for decision-making should be supplied by the economic intelligence and outlook organization described in a later section.* This organization should have full responsibility for the collection and analysis of agricultural and related economic data. It should review the supply, demand and price situation on a continuing basis and present the results of its appraisal to the policy group as a basis for their decisions.

Flexibility in Developing the Programme

Prudence requires a conservative approach to establishment of price guarantees in the early phase of a price stabilization programme. It is especially desirable that adequate staff be available to carry out the programme effectively and with dispatch. As a beginning we suggest that minimum prices be established only for rice and wheat on an all-India basis, and other important grains on a regional basis. Unless domestic considerations indicate the need for establishing floor prices on the basis of other criteria, consideration should be given to setting the first floor prices 10 to 15 per cent below prevailing import prices for each commodity, depending upon the proportion of imports to production. So long as the floor price is below import price, there need be no fear of financial loss in a country where imports are likely to continue for some years. . .

The floor price should be announced to cultivators before sowing time and remain in effect for one full year. A further announcement should be made that floor prices will be established for an additional two years at levels 10 to 15 per cent below the import price, at a stated

* See Part III, Chapter II.

time each year. The actual prices are likely to rise above the minimum levels, at least in some years.

A floor price established in this way would permit annual adjustments to existing and prospective conditions. After experience has been gained with the first three years of operation, the programme could be renewed. Floor prices for other crops could be added as experience indicates the need for a broader programme.

Storage and Marketing Structure *

The price stabilization programme should leave the major responsibility for the movement of food grains to marketing cooperatives or private traders, with the Government intervening only to the extent required to guarantee minimum prices and to even out supplies.

At points of surplus, the Government should stand ready to buy at the minimum price any quantity offered for sale. At deficit points, the Government should stand ready to supply food grains through fair price shops. This requires that the Government be in possession at all times of stocks to use as a price lever.

Import of food grains can be of material assistance in operation of a buffer-stock programme. The food-grain imports that have been available under special programmes have relieved the pressure on foreign exchange. No exact recommendations can be given on amounts to import in any year because this involves considerations of domestic production, substitution among food grains, availability of foreign exchange and willingness of foreign countries to make supplies available under special programmes.

* This subject is treated more fully in Part III, Chapters I and III.

CHAPTER I — BETTER ECONOMIC AND ADMINISTRATIVE ARRANGEMENTS

2. LAND REFORM AND FOOD PRODUCTION

Stability of Tenure

Assurance of stability of land tenure and equitable rental arrangements can contribute substantially to food production, but insecurity of tenure has a retarding effect. Many tenants do not have sufficient security to participate in land improvement, and some of the share-cropping arrangements definitely discourage adoption of improved practices.

In some areas uncertainties with respect to the application of land ceilings are at present retarding private investments in agriculture that could result in additional food production. *Such retardation emphasizes the urgent need for passage of land reform legislation at the earliest possible dates, and then for immediate execution of the provisions of such legislation.* Only in this way can uncertainties be eliminated, and assurance be given to cultivators so that they can safely make desirable land improvements.

Cultivators need to know that their tenure will remain stable for a sufficient period of time to permit them to receive expected returns from investments in land improvement.

We recognize the need for considering programmes for the relief of those who have no land, and of those who cultivate too little land. But it is *imperative to achieve this objective in ways that will not retard the increases in food production which are vital to national welfare.* Some progress can be made by arranging for reallocation, improvement and operation of potentially productive lands that are now idle, or are being used very ineffectively. Care should be exercised, however, so as not to break up farms that are efficiently and productively operated.

The longer term objectives of a land tenure programme also must be kept in mind. These would include development of a labour intensive, but nevertheless efficient agriculture. To achieve this end requires intelligent and capable leadership on the part of cultivators. This leadership must come from a strong group of progressive cultivators, who will move forward in adopting new technology, and other measures for improvement of the farms and the villages. Land reforms must not discourage development of a progressive group of cultivators who have middle-sized holdings.

Unfortunately, insufficient research is available in India on which to base decisions concerning desirable land tenure programmes. Arrangements should be made to analyze current data concerning distribution of ownership and tenancy by areas in each State, and by size of holdings and types of tenure. Research should also be undertaken to determine the advantages of various sizes of farms under prevailing and improved methods of production, and for individual as well as cooperative operations. Rental arrangements, including crop-sharing, also need to be studied,* with especial reference to their

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* See Part III, Chapter IV, on research in agricultural economics.

bearing on adoption of improved farming methods and thus on increased food production.

Size of Holdings

Too many people are attempting to earn a living on the land. Available data indicate that there are only about 5.3 acres of net cultivated land per family dependent on agriculture. Of this 5.3 acres, a little over one acre would be irrigated land.

Even if these land resources are fully developed, they are not sufficient to provide a living for all the families now dependent on the land. And they are certainly inadequate to provide for the projected increase in village population (an increase of 45 million by 1966). Consequently, *income improvement for the landless and for those with too little land must be sought in ways that will permit subsequent adjustments in land holdings and in farm sizes when non-farm employment opportunities can be arranged for those not needed in agriculture.*

As non-farm employment expands, India should expect greater mechanization of its agriculture. Larger farms may then be needed for more efficient operations than can be provided under present conditions. *Care should be taken, therefore, to avoid freezing a pattern of land tenure that cannot later be modified to meet changing conditions.*

It is just as necessary to establish a minimum standard of land resources per family as it is to set a ceiling on land holdings. The minimum standard necessarily will vary in acreage, depending upon the physical productivity of the land, whether it is irrigated or unirrigated, and its location with respect to markets. Consequently, the minimum standard will need to be adapted to local conditions, but the general principle of a minimum unit for adequate living for a farm family must be kept in mind.

The concept of a minimum unit of land per family is equally applicable to private or to cooperative operation of land. If land resources per family are insufficient, neither cooperative nor private operation can provide an adequate living.

Cooperative Farming and Land Use

Present policy discussions include suggestions that joint cooperative farming societies be organized for operation of land now poorly utilized, or for areas acquired by application of land ceilings. It is understood that joint farming cooperatives will be organized on a voluntary basis. Undoubtedly, some time will be required for organization and efficient operation of many cooperatives of this type.

While experience is being gained by careful analysis of the first cooperative farming ventures that are established, attention can also be centred on alternative ways of accomplishing cooperation in farm operations. For example, *present owners or tenants operating small units could be encouraged to arrange for joint ownership and operation of bullock or mechanical power, and for use of the necessary equipment.* Such operation permits individual attention by the cultivator to his unit of land.

This approach to cooperative farming might also be tried in organizing operation of land allocated to the landless. Each family could be assigned a parcel of land as his individual unit of operation, but with the understanding that the title will remain with the State. Then a group of these families could be assisted in joint ownership and operation of power and other equipment, as well as in the planning and conduct of their farming operations.

The advantages and disadvantages of joint cooperative farming should be analyzed carefully and objectively. Under capable management, operation of large consolidated tracts can result in greater efficiency. Where larger scale operations can be undertaken, equipment can be purchased for better tillage, more timely operations, water management, pest control, etc. But it should be recognized that in many areas the land that will become available will not be suitable for operation in large tracts.

Even where large tracts are available their successful operation on a cooperative basis requires competent management. But in practice, capable managers may often not be available. At the same time, the individual incentive for careful tillage of the separately owned plot of land is lost in the pooling operation.

As an alternative, a limited number of trained managers could be assigned to work with individual cultivators on a less intensive basis than would be needed for joint cooperative farming.

*Management assistance to cultivators, combined with supervised credit, and perhaps with joint ownership of equipment, offers a way to obtain the advantage of better management while still retaining the incentives gained by individual operation.** The magic of individual attention to the land may not "turn sand into gold," but there is ample evidence that it can constitute a powerful drive for improvement of operations.

Other Means of Helping the Landless

Other ways of improving the condition of the landless labourers must also be found. *Many landless labourers would no doubt consider more secure employment, at somewhat higher wages than they now get, just as much of an improvement in their conditions as membership in a joint farming cooperative.* The public works programme suggested in the following section would provide temporary work, but the long-term solution depends upon economic development that will provide more non-farm employment. In this connection more attention should be given to establishing cooperatives for processing farm products in the villages.**

In addition to wages and more secure employment, garden plots should be provided to wage workers. Many villages have lands that can be cultivated as home gardens. Such areas would need to be protected against livestock depredation, but it should be possible to make such arrangements.

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* An experimental project in the use of farm management assistance to groups of cultivators is described in Part III, Chapter XV.

**See Part III, Chapter I, for a fuller discussion of this suggestion.

Consolidation of Fragmented Holdings

The fragmentation of holdings reduces efficiency of farm operations and especially of water management. For example, on many millions of acres, food production can be greatly increased by appropriate bunding and terracing, *but only* if these structures are placed correctly in relation to the contour. And this requires consolidation of holdings. The types of bunds or terraces to use vary, of course, with the kind of soil.

Land consolidation is going ahead in several states. Some of the results have been excellent in terms of increased food production, higher incomes, and reduced erosion. Unhappily, some programmes are not coordinated with those for irrigation, drainage, and bunding, in order that the necessary structures of the minimum lengths can be built in the places needed for greatest effectiveness and economy. But good coordination can be achieved and has been achieved successfully in many Indian villages.

By carrying on land consolidation with soil and water conservation planning, land areas can be laid out so that field irrigation, canals, drainage ditches, contour bunds, and stone terraces are on the boundaries between holdings, or parts of holdings. Such locations of field boundaries are very important. It is not always necessary or even desirable to bring all the land of one holder into a single block, especially where two or more contrasting soils of unlike management requirements are involved. It is more desirable to bring together those fragments of holdings that have similar soil.

Since land consolidation requires satisfactory settlement of tenure problems, prompt action on all phases of tenure and land ceilings is urgently needed.

Because of the obvious benefits from land consolidation where it is carried out with full regard to the needs for soil and water conservation, a definite schedule should be worked out to complete the job, village by village, as soon as practicable. *In any area where consolidation is begun, it should be completed within a definite time period in order to avoid uncertainties and a lowering of production.*

Immediate steps should be taken: (1) to initiate soil surveys and topographic surveys, where needed, ahead of planning for consolidation and with highest priority to areas of contrasting soils; and (2) to insure that planning for consolidation takes full account of needed field structures for irrigation, drainage, and contour bunds. In fact, a poor job of planning may result in few benefits and great confusion later when a proper scheme is attempted.

With full coordination in the planning, once work begins in a village, it should be pushed forward as rapidly as it can be done well, and concurrently with the soil and water conservation work. In any case, it is necessary to avoid undue disturbance of current production and to get the advantages of the improved system as soon as possible.

We recommend, therefore, that *firm plans be developed immediately* to schedule the completion of the consolidation of fragmented holdings, village-by-village, as soon as possible. The work should be based upon adequate soil surveys and on a coordinated plan through

which the boundaries of holdings could fall on the same lines as drainage ditches, irrigation canals, contour bunds, stone terraces, and similar structures. *We also recommend that high-level coordinating agencies be established at the Centre and in each State to develop schedules, and to insure effective coordination with the requirements for soil and water conservation, giving* special emphasis to needed structures for water control, distribution, and disposal.

Many States now have laws for undertaking land consolidation. Not all have laws to prevent further uneconomic fragmentation. Such laws should be enacted in States and necessary enforcement should be provided for. *We, therefore, suggest that draft legislation be prepared and submitted for consideration of the States not now having such laws, to prevent fragmentation of small holdings into tiny uneconomic units.*

CHAPTER I — BETTER ECONOMIC AND ADMINISTRATIVE ARRANGEMENTS

3. A PUBLIC WORKS PROGRAMME TO INCREASE RURAL EMPLOYMENT AND TO PROVIDE MORE FOOD

The unemployed and underemployed in the villages of India represent a significant waste of human resources which could contribute to producing more food. Non-farm employment will develop only slowly for these village people, and they cannot all be productively used in farm operations. But excellent opportunities exist for putting unemployed and underemployed rural people to work on public projects which will directly improve the productive capacity of agriculture.

We, therefore, propose that a public works programme be instituted in the interest of increasing rural employment and at the same time increasing food production.

Projects undertaken under this programme should be limited to those:

1. Which will have a direct effect on food production;
2. Which require little or no capital expenditure, and can be carried out primarily with hand labour;
3. Which require little or no scarce material and little or no foreign exchange;
4. For which people with the necessary skills to supervise the work are available or can readily be trained.

Priority should be given to projects in those areas where serious rural unemployment prevails and, within those areas, to activities which will make the greatest and most immediate contribution to food production.

Bunding and Terracing

An outstanding example of a type of project that can be undertaken in appropriate areas is contour bunding and terracing (including masonry terracing), accurately laid out in relation to contour and slope. Large and immediate increases in food production can result from such work, where it is well done, and where the cultivators are prepared to use such other good farming practices necessary for full effectiveness. Since bunding and terracing work must cover an area completely, it will be necessary for the affected villagers to agree to the project.

Other Projects

As people can be trained and the work organized, other soil conservation and water utilization measures can also provide employment and food production increases. Land levelling, surface drainage, minor irrigation works, construction of wells and tanks—all these would provide suitable projects under this programme. Where villages lack adequate approach roads for bringing in supplies and taking produce to market, these could be included as useful projects. Where village godowns are needed for better storage and preservation of food, these too might be constructed.

Although the returns measured in food production would come later, consideration might in some areas be given to the planting of fruit and fuel trees on village common lands. Protection of productive lands from livestock depredations might also provide employment, and in many areas would increase food production significantly.

It should be noted that while wages paid to these workers would increase their purchasing power, more food would be produced not only for those who do the work but for other consumers as well. Hence *a works programme of this type need not be inflationary.*

A public works programme to serve these purposes will need careful organization. Arrangements should be made to utilize existing agencies. To the extent practicable, village panchayats should assume responsibility for designating the unemployed and underemployed labourers, and for other aspects of particular projects. But to be effective, *approval of projects and supervision of the work undertaken must be the responsibility of a State or Centre Government agency.*

CHAPTER I — BETTER ECONOMIC AND ADMINISTRATIVE ARRANGEMENTS

4. THE ROLE OF COOPERATIVES IN EXPANDED FOOD PRODUCTION*—Credit, Marketing and Supply

Present credit, marketing and supply services in the villages are a major deterrent to increasing India's food production. Over 85 per cent of the credit which cultivators use is provided by money lenders and other individuals. Most of their small marketable surplus is sold to traders at depressed prices at harvest time. Many cultivators are not getting full value for their produce, are paying exorbitant rates of interest for inadequate credit, and do not have a reliable source of production supplies. Thus, they are unable to adopt many improved practices for increased production.

Yet the cultivators, acting alone, are incapable of breaking loose from their poverty-stricken status. Only by cooperative effort, with Government assistance, can the stranglehold of money lenders and traders be broken.

But there is no magic in the cooperative form of organization which assures its success. Cooperatives will succeed only if they perform economic functions better than they are now being performed. They will be able to do this only if they are built upon sound business principles. They must have sufficient capital to provide adequate working funds and sufficient income to pay necessary operating expenses, including the cost of competent management. To develop strong cooperatives, therefore, Government help must not be niggardly in respect to both financial and technical assistance.

Extending Credit through the Primary Society

Present plans make no provision for the States to advance loan funds to the smaller primary societies. *We believe that the primary societies must become important in the extension of credit in rural India. To achieve this goal, the State Governments must advance loan funds to supplement the capital investment of the members, to provide a capital base large enough to support the complete borrowing needs of cultivators.* If this is done, the Reserve Bank can then provide the necessary loan funds through the cooperative bank system, so that no society will be forced to deny a loan or give an inadequate loan because it does not have sufficient resources.

We believe further that there should be no specific due date by which time the Government advances would be repaid. The advances should be retained by the society until it has adequate resources of its own to serve its members and potential members. The terms for repayment should be established by agreement, and should be based upon the relationship of the society's net worth to risk assets. *During this period of capital formation at the local level, the banks and societies should forgo the payment of dividends so that all earnings may be applied to increasing net worth.*

* A fuller discussion of cooperatives is included in Part III, Chapter I.

Such a procedure would benefit the societies and banks in many ways. They would have added resources as a cushion against adversity. They would have more of their own funds to invest in loans which would reduce their borrowing and interest costs and permit the giving of more rapid service. The Government advances could be repaid and the cultivators become the complete owners of their society more rapidly.

Although the village is the basic social unit in rural India, there is great variation between villages as to size, relative economic status, availability of markets, type of agriculture conducted, etc. These and other variables make it necessary that cooperatives be built to fit the circumstances existing in the specific area to be served. *We believe that the structure of a primary cooperative society is not as important as the results it achieves.* Fundamental principles of cooperation must be adhered to, but the type of functions a society performs, the nature of its membership, and the number of villages served will have to be determined by the circumstances found in each situation.

This flexible approach to cooperative development requires intensive educational work with the village people regarding the principles of cooperation and the opportunities cooperatives present.

Very little of this type of educational work is being done at the village level. *It is the opinion of this Team that the extension staff, especially at the block level, must be strengthened in this respect by adding sufficient personnel to do intensive educational and promotion work on cooperatives.** These people would need to work with the central cooperative bank, with the cooperative unions (where they exist) and with the VLWs, but they should take initiative for carrying out the educational and promotional assignment.

Credit Worthiness

There are a variety of standards which can be used to determine who is entitled to credit. In India today credit worthiness is most often based on the value of pledged assets. Although the Reserve Bank and a few States are encouraging production loans upon the basis of expected crop yields and repayment ability, we find that in a large part of India this procedure is taking hold only slowly. Yet we are convinced that if this approach to lending could be adopted immediately by primary societies and cooperative banks, it would make an important contribution toward increasing agricultural production.

Timely Credit Service

It has been reported on numerous occasions that delays in approving loan applications were an important factor in stifling the effectiveness of primary societies in the extension of credit. Periods up to five months have been reported from the date of the cultivator's application for short-term credit to the disbursement of his loan. *It is essential that operating procedures of primary societies and cooperative banks be simplified so that cultivators can obtain loan funds from their society in a reasonable period of time.* New applications for short-term

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* See the following section and Part III, Chapters I and VI, for an elaboration of this suggestion.

production credit should not require over a fortnight for decision. A cultivator with a good record of performance with a society should be able to receive approval of a normal credit request within a few days. For small amounts he should be able to obtain the funds "over the counter." Only by this kind of service can the society meet the entire credit requirements of its members. And until this can be done, the cultivators will have to resort to the money lenders for emergency credit.

Credit and Agricultural Technicians

We have found that the cooperative banks and primary societies generally are not familiar with the agricultural programmes being conducted in their areas, nor are they acquainted with their agricultural technicians. *There should be close working relationship between the agricultural technicians and the officials of both the primary credit societies and the cooperative banks, in order that technical agricultural knowledge be used to strengthen repayment capacity, and enhance loan recovery probabilities.*

The extension of credit upon the basis of repayment capacity requires an intimate knowledge of agriculture. We believe, therefore, that agricultural college graduates should be used to a greater extent than presently in the primary societies and cooperative banks. It would seem logical, considering the importance of cooperatives to India, that the agricultural colleges develop a curriculum especially designed for future managers of cooperatives.

Marketing and Supply *

The marketing and supply phases of India's cooperative development are newer and consequently less developed than the credit phase. Substantial progress has been made in recent years in organizing marketing cooperatives, with 1,200 marketing and supply cooperatives already organized at mandi centres, and 800 in the process of organization. But the flow of produce and goods through these cooperatives has not developed to any great extent. In most States, they are in a position to distribute fertilizers. But this activity needs to be expanded.

As discussed in sections of this report on improving extension work, we feel that *the cooperative departments of the States and their staff in the field should, as rapidly as they are able to do so, assume responsibility for organizing and servicing the agriculture supply lines.* While there will always be a place for the enterprising honest private entrepreneur who wants to make a business of stocking and selling agricultural supplies, cooperatives must play an important role in supplying the cultivator with the tools, fertilizers, seeds, etc., for an intensive food production campaign.

*We believe that strength could be given to marketing and supply cooperatives by using them as agency for price stabilization.*** Quite commonly food-grain shortages exist in urban areas and in those rural regions which are not major food-grain producers, while elsewhere surplus grains are available and prices may be quite low. State purchase operations through marketing cooperatives in surplus areas would

* See Part III, Chapter II, for a discussion of particular aspects of marketing.
** This subject is discussed more fully in Section 1 of this Chapter.

have the effect of strengthening prices there. Movement of these supplies through cooperative marketing societies in deficit areas would ease inflationary pressure and further develop the cooperatives' facilities.

To be effective, *marketing and supply cooperatives must have godowns to provide safe and adequate storage.* There should also be a godown available to each village, under control of the primary society in which the small quantities of the marketable crops of the villagers can be stored until delivered to the marketing cooperative. These village godowns would also provide storage space for supplies, for seeds and food grains for village use.

We believe that the possibility of using funds from grain imports for godown construction should be investigated fully. It is possible, for example, that (PL 480) funds resulting from sale within India of grain from the United States might be available for this purpose.

In general, primary societies do not have capital resources to carry large stocks of supplies. To be effective in meeting the village cultivator's requirements, they must have access to centres where they can place orders with assurance of rapid deliveries.

The federation of a group of village cooperatives into a mandi cooperative, with a warehousing centre, will be both wise and necessary. There must be a very close relation between the two. At least six months in advance of village needs for specific supplies, these projected needs must be communicated to the mandi cooperative by the village cooperative, so it in turn can stock the supplies in sufficient time.

The mandi cooperative should in turn set up its contacts with distant sources of supply of seeds, fertilizers, etc. It should also take leadership in initiating the manufacture of supplies which can be made in the village, such as agricultural implements and certain insecticides, and in organizing small industries for the processing of foods and fruits grown in the area. Also appropriate would be the establishment and operation of poultry hatcheries and the maintenance of small nurseries to supply fruit trees and vegetable plants.

With the affiliation of village cooperatives into a mandi cooperative, a sufficient volume of business is possible to employ competent management, establish adequate accounting procedures and engage in educational programmes with the affiliated village cooperatives.

Food Processing

The processing of agricultural produce is a complementary activity of cooperative societies which could be expanded. Because of the heavy investment required, marketing societies often need to join forces to build processing plants. This is true with respect to cotton ginning, sugar mills, etc. The required investment for paddy hulling or rice mills, on the other hand, is relatively small and could be borne by individual societies. It is interesting to note, however, that most of the cooperative activity in India in the processing field is in connection with cotton and sugar where large investments are required. *It appears to us that the greatest need to-day is for more cooperatively owned paddy hulling and rice mills in major rice-producing areas.* Efforts to market rice cooperatively have not been too successful and the lack of processing facilities has been frequently reported as a major contribut-

ing cause. The present ban on new paddy hulling plants is keeping cooperatives out of this activity. Some means should be found to let cooperatives enter this field.

The future of the cooperative movement in India depends upon the people who lead, direct and manage it. In addition to many qualified people in the Government, India has capable, well-informed and educated people in the cooperative movement itself. This "non-official" group can provide informed and practical information essential to the development of sound and practical policies and plans. Their counsel and advice should be sought. *Unless "non-official" leadership is recognized and developed, cooperatives will be led and dominated by Government. This is not India's objective as we interpret her plans.*

CHAPTER I — BETTER ECONOMIC AND ADMINISTRATIVE ARRANGEMENTS

5. IMPROVING EXTENSION WORK THROUGH COMMUNITY DEVELOPMENT*

India's village families — men, women and children — hold the key to increased food production. More food will be produced only as rapidly as the nation's farmers and their families understand and adopt improved practices. This is the job of extension.

For effective extension there should be (1) programme goals for greater production set by village cultivators with the aid of extension workers, and (2) an administrative organization to motivate and assist cultivators in applying improved practices suited to local conditions and essential to reach the goals set.

Extension Programmes

India has made considerable progress in developing an extension programme and an organization for working with the cultivators. But much more needs to be done. Extension programmes in India can have a much greater impact upon food production and this is necessary for the nation's survival. Extension programmes can be improved by focusing *them more directly upon local conditions, upon village production problems and production potentials, and by having village farmers participate more actively in programme determinations, including setting the priority order of programme action.* This process in itself leads to mental growth and development of leadership in village people. Women and youth should be included in these efforts. We, therefore, recommend:

1. *Block extension workers should set up village food production committees* through which the local farm people, assisted by block extension personnel and VLWs, first, can assess the present production and optimum productive capacities of village farms, and, second, determine the combinations of improved farming methods necessary to achieve expanded production. Where the village has a panchayat, the food committee could act as a sub-committee of the panchayat.

2. Targets composed of improved practice quotas handed down to the blocks and villages from national and State levels should be abandoned. The use of targets should be confined to national and State requirements for key food crops and be used by the village cultivators as guides in setting their own food production goals, in consultation with local extension workers.

3. Special extension programme emphasis should be given to the important contribution that farm women and youth can make in village community efforts to step up food production.

4. Caution should be exercised in making recommendations for any improved practice uniformly over large areas without adequate regard for their appropriateness for local farming conditions.

Extension Organization and Administration

The extension programme is conducted through the block staff organization of the State Development Commissioner's office, supported

* A fuller discussion is included in Part III, Chapter VI.

by the technical staffs of the State agriculture, animal husbandry, and other departments. Mobilizing the nation's farmers to expand food production through extension education is the joint responsibility of these organizations. *To achieve greater farming efficiency and expanded output*, we recommend:

1. The community development organization from the Centre to the blocks should focus its extension programme more fully on increased food production. The emergency nature of the present food situation requires much more than issuing directives that the VLWs should spend 75 to 80 per cent of their time on agricultural production.

The top priority programme objective of community development in the foreseeable future must be to marshal the educational force and drive that will stimulate village cultivators to produce more food. The application of many more technological improvements, and the vigorous impact of science, are greatly needed at the field level in order to obtain the magnitude of production required. This demands the use of technical agricultural specialists in the blocks and also other adjustments in current block staff assignments.

Additional block agricultural personnel with specialized technical competence to handle local farming problems, such as irrigation, soil conservation, farm management and home science, are needed; and more intensive technical and extension methods training must be given to all present block staffs as rapidly as possible. Adjustments in block budgets are also called for.

2. Immediate steps must be taken at the Centre, State and District levels to strengthen extension work. Unless the block staffs are adequately supported by a core of agricultural subject-matter specialists up the line—specialists who are continuously in touch with current research developments—the local staffs cannot be expected to carry on successful extension programmes to increase crop yields by modern farming methods.*

At the Centre, some of the nation's most competent agricultural technicians and scientists—in such fields as rice and other cereal crop production, irrigation, plant protection, soil fertility, animal husbandry, farm management and agricultural economics—must be recruited to give broad, general leadership to State extension specialists. The men selected must be capable of commanding the complete respect of their opposite numbers in research. At State and District levels men of similar qualifications are needed to give leadership and direction to the men in blocks and villages.

The shortage of technical personnel requires that care be exercised in building up this technical staff to avoid undue disruption to on-going research work important to food production. In some cases, research workers at colleges and experiment stations might be used for this purpose on a part-time basis.

The kinds of State-wide and District farming problems impeding greater food production should determine the special technical qualifications of these extension workers.

* The relationship of research to extension is of great importance and is discussed at several places in other sections of this Report. Some general comments appear in Part III, Chapter V.

3. In the interest of securing more rapid farming improvements throughout the country, the approximately 2,000 "shadow" blocks (that is, the blocks not yet under the community development programme) should receive at least a minimum of extension educational assistance. These areas should be manned with a full complement of agricultural assistants and field demonstrators, and these extension workers should also receive periodic subject-matter and extension methods training.

4. The following changes in assignments of officers at the block level should be made:

a. *Village Level Workers*: Relieve the Gram Sevak of service tasks, such as handling farm supplies, loan collections, etc., as rapily as these jobs can be assigned to other persons. Direct more of the activities of the Gram Sevikas to teaching improved agricultural practices to farm women.

b. *Agricultural Officer*: Relieve him of service responsibilities such as seed, fertilizer, and insecticide handling, assigning this to cooperatives and to the Cooperative Officer.

c. *Animal Husbandry Officer*: Reorient his work toward food production, for example, giving greater emphasis to poultry production, where applicable, and greater emphasis to forage utilization and controlled grazing.

d. *SEO (Man)*: Assign him as a staff officer to assist the BDO and other block officers in organizing facilities and in preparing visual materials and other teaching aids with particular reference to agricultural production, and to assist the VLW in organization, method demonstrations, etc.

e. *Cooperative Officer*: Encourage him to take greater responsibility for developing an understanding of the purpose, objectives and opportunities of cooperatives and aiding in their organization. Make him responsible for the supply functions such as seed and fertilizer currently usually handled by the agricultural officer.

f. *Other Officers*: The work of the engineer, panchayat officer, woman social education organizer should be redirected, to the extent possible, to educational activities and development programmes contributing directly to greater food production.

5. State Departments of Agriculture should provide adequate agricultural information services to help extend information on improved practices through mass communication media, such as radio, newspapers and pamphlets, and by visual teachning devices—movies filmstrips, posters, and so on. Information services can support the work of local extension personnel by making farmers more aware of better farming methods, and by providing the local workers visual and other teaching aids.

6. Conditions contributing to rapid personnel turnover, such as low salaries, job insecurity and limited opportunities for advancement, should be remedied. This is particularly a matter of concern with respect to VLWs, but would also improve the quality of work done by extension personnel up the line. A part of these personnel problems can be solved by staff supervision oriented to worker counsel and guid-

ance and to general personnel development rather than to inspection, order-giving and control. Administrative steps must also be taken to correct the more crucial problems of job insecurity and low morale resulting from insufficient opportunities for advancement.

7. With respect to block budgets and accounting and auditing procedures, greater budget flexibility from block to block is needed. Budgets should reflect priorities set by the local people and the block staff. Accounting and credit inspectors need a better understanding of extension programme objectives. Rigidities and complex paper controls place the local extension workers in "strait jackets" and consume time that should be devoted to the business of aiding farmers to produce more food.

8. The reports required of extension workers should be simplified, and consist of periodic descriptive statements of extension programme achievements, with expanding food production as the central theme. The present detailed reports of VLWs and block extension officers appear to give more emphasis to mechanical paper control than to assessing programme results.

9. To mobilize the manpower of State-level personnel concerned with food production programmes fully, each State should convene a working conference of community development and appropriate technical department officers and specialists for the purpose of: (a) assessing and outlining the jobs to be done to aid local extension workers and village cultivators to produce more food, and (b) fixing the specific responsibilities of each department for carrying out the plans. Each such State conference should be followed by a series of District conferences in which all appropriate District personnel, official and non-official, would meet to appraise the food production potential of their respective Districts and determine and assign responsibilities for jobs to be done to support block staff extension programmes with technicians, teaching equipment, materials and demonstration supplies.

Extension Methods

India's extension education programme can be much more effective if agricultural extension workers at all levels develop more of the skills for conducting an effective educational programme. To achieve this, they must have a better understanding of human relations generally and of: (a) the social-psychological make-up of the cultivator, (b) the mental processes of the cultivator in learning and acting, and (c) the cultivator in his social setting in the village.

With respect to extension methods, we recommend:

1. Competent instructors in extension education should be secured or trained for the extension training centres, and a more comprehensive and practical work-training syllabus, including content and methods of teaching, should be developed.

2. A critical analysis should be made, in the field, of extension methods now being used and of any others that may be valuable, to determine how extension programmes in action may most effectively persuade the village farmers to adopt farming improvements.

3. Village leader training camps are an excellent method of extending and maximizing the limited resources of local extension

staffs available to encourage greater food production. These camps should be continued and expanded in number, so that full advantage can be taken of local progressive farmer leadership, capable of influencing neighbouring farmers to adopt efficient practices. Extreme care should be taken in planning the programmes of these camps to make certain that the subject matter taught relates clearly to increased food production.

CHAPTER II — BETTER USE OF PHYSICAL AND BIOLOGICAL RESOURCES

1. SOIL AND WATER CONSERVATION (INCLUDING WATER USE)*

India has the basic natural resources of soil, water, climate, and labour, for abundant food production. High production results only when combinations of soil, water and crop management are adapted to local conditions and are skilfully applied by individual cultivators. Costs for irrigation works and for contour bunding, for example, are rarely returned unless the water is well controlled and unless fertilizers, good seeds, and other appropriate cultural practices are also used.

This principle of combined practices—of fitting the various practices together as adapted to each kind of soil—is the very cornerstone of any successful programme for soil and water conservation that gives efficient, sustained production at a high level.

Eighty per cent of the annual rainfall, over the greater part of India, is received in less than four months. Since India has a tropical or sub-tropical climate, it has a potential to grow crops on a year-round basis. An adequate water supply in the soil can provide opportunity for increasing crop production several fold. Often too much or too little water and its inefficient use are primary limiting factors to increased crop production. *India is blessed with one of the largest water supplies of any country in the world, but only a small portion of its potential has been developed.* Continued emphasis, therefore, should be given to the development of irrigation water supply through storage reservoirs and direct diversion from rivers and streams which will permit water delivery on a continuous yearly basis.

Wells and Tanks

Wells must be considered as a source of water supply, where stream flow is only seasonal (during monsoons) and where storage from reservoirs is not feasible. In these areas consideration must be given to providing crop requirements either directly from wells or by supplementing stream flow with well water. In determining the feasibility of such projects and the cost of irrigation *it is essential to relate the cost of irrigation to the benefits to be derived in terms of physical crop yields and related social benefits.*

The potential exists in many areas for the development of tube and shallow masonry wells that would make possible the growing of 2 to 3 crops per year with resulting tremendous increases in food production. In some areas, villages would now develop tube wells with their own money if the materials were made available to them. In other cases, loans and/or subsidies are needed.

Shallow masonry wells can each irrigate only a small acreage, but their cost is small and their power requirement is low. And most of the requirements of construction and power can be met within the village.

Irrigation tanks provide water for approximately 10 million acres in India. There is opportunity for economic construction of many more

* See Part III, Chapter VII, for a complete report on this subject.

tanks. In addition to providing water for increased food production, these tanks also have many social benefits to the immediate villages. In some cases loans or subsidies may be needed to obtain the desired number and proper construction.

We, therefore, recommend that:

1. *The tube-well programme should be greatly expanded in those areas where there is now a relatively sure supply of good ground water.* This would include large areas in Uttar Pradesh, Punjab, West Bengal, Bihar, Madras, Andhra Pradesh, and parts of Bombay and other States. Those areas which have potential for 2 and 3 crops per year should have highest priority.

2. *The programme for shallow masonry wells should be expanded to meet the maximum demand* consistent with good irrigation planning.

3. *The development of tanks should be encouraged, and public assistance, through loans or subsidies, should be given for their construction and repair.* (The construction should be in accordance with Recommendation 15 of the detailed report on soil and water conservation in Part III of this Report.)

Improving Water Conveyance

Seepage losses of water occur during transport regardless of the source. The more serious of these are found in the large surface projects. In many irrigated areas, Indian studies have found that half the water diverted from rivers and streams is lost in conveyance, and half the water given to the fields is lost before it gets to the roots of the plants.

Improved water conveyance, within the village and on the farm, land preparation for uniform water distribution, and proper practices as to time and amount of water applied for various crops, soils and climates, offer some of the greatest opportunities for increasing food production. To get such practices used correctly on irrigated lands, and for contour bunding, terracing, and land levelling on non-irrigated areas, requires technical assistance to the farmer.

We, therefore, recommend that:

1. *Seepage studies should be made in the canal systems losing more than 15 per cent of their water; where excessive seepage is occurring, action should be taken to reduce it.*

2. *Each State should provide for a staff of technicians in soil and water conservation, not only for project work but also for direct technical assistance to cultivators* and groups of cultivators as the need is identified by agricultural extension officers.

Good Water Management

India now gets only one-fifth to one-fourth ton increase in crop yields on irrigated lands as compared to non-irrigated lands. Moreover, only about 12 per cent of irrigated acreage grows more than one irrigated crop per year. India cannot afford this waste of resources. Better water management is needed. In fact, *India can make greater and more immediate gains in food production by intensifying expenditure of time*

and effort on water management on farms than by constructing large-scale irrigation projects which take years to develop. The Third Plan should allocate substantial funds for technical assistance to aid cultivators in making better use of available water. *Provision must also be made for a more comprehensive approach, with coordination of all relevant departments.*

Changing from non-irrigation farming to irrigation farming is a slow process, for most farmers, unless the benefits of irrigation farming are effectively demonstrated to them, together with the practices necessary to obtain them.

We, therefore, recommend that:

1. *An increased effort should be made through technical assistance, extension and demonstration to get improved water management practices, combined with proper fertilizers, recommended seeds and cropping systems on farm fields as rapidly as possible.*

2. *Research experiments and demonstrations should be greatly expanded to deal with the proper combinations of (a) water management, (b) fertilizers, (c) good seeds, (d) other cultural practices necessary for high production.*

3. *An adequate percentage of the total cost of each new major irrigation project should be earmarked and made available through appropriate agencies of the Agrcicultural Department*, so that funds necessary to start demonstrations of irrigation farming and other phases of their programmes will be available at the same time the engineering construction phases of a new project are begun.

Drainage and Salinity

Excess water during the monsoon rains frequently handicaps much of India's agriculture to the extent that it creates major problems of surface drainage and contributes to waterlogging and development of saline and alkali soils. The surface drainage problem is magnified because of the interference with flow capacity in natural drainage-ways by roads and irrigation canals. Paths made by farmers and villages also add to the problem.

There are places in India where millions of acres could be reclaimed and made productive by surface drainage at less cost and in less time than by developing new irrigation projects. The portions of these areas that appear to be most productive and that have the possibility of 2 to 3 crops a year should be given highest priority.

In the Punjab alone, for example, waterlogging exists on some 3 million acres of land with a serious rising water table on at least an additional 3 million acres. An immediate programme should be started in the Punjab, and other States having similar problems, to provide adequate surface drainage. The irrigation and drainage people in the Punjab are doing some work on these problems and they have some major drainage plans. *But this programme should be given a much higher priority for development and be put on the land at a much faster rate.*

Seepage from canals has been the cause of large areas going out of production, but only in a few projects have drains been installed to relieve waterlogging.

Apparently, there are very few places where drains have been constructed prior to the actual waterlogging of the soil. Yet, it is easier and more effective to prevent waterlogging and its accompanying salt and alkali problems ahead of time, than it is to reclaim the soil after these conditions have developed. In many cases, salt and alkali problems are not adequately evaluated, since their harmful effects develop gradually. First the yield is reduced slightly and then to greater and greater extents, and finally complete crop failure results. Commonly, only the final stage is recognized.

A recent study, available in C.W.P.C., reports that 3 million, 2 million and 2½ million acres of land in Punjab, Uttar Pradesh and West Bengal, respectively, have a water table within 5 feet of the surface, and an additional 3 million acres in Punjab have water tables at 5 to 10 feet depths, and that a considerable portion of these areas grow either no crops or very poor crops. We have found there is considerable controversy as to the reliability of these figures. The Team, however, believes the problem is of sufficient importance to warrant further investigation.

These problems of drainage and salinity are so important that some single agency, probably the Irrigation Department, should be given the responsibility for broad coordination and improvement of natural and artificial drainage ways. The agency should have authorrity to enforce regulations prohibiting interference with flow capacity of drainage ways. Plans for the construction of highways, railroads, and canals should enhance drainage, not interfere with it.

We, therefore, recommend that:

1. *One agency should be given the responsibility for coordination and improvement of natural and artificial drainage ways, and that the improvement of natural drainage ways be given a high priority.*

2. *Research and demonstration should be expanded on the reclamation of water-logged, saline and alkali soils, and that increased efforts should be made to reclaim present areas so affected, but that no tiling or internal drainage should be started until after surface drainage has been effected.*

Bunding and Terracing on Drylands

If the Second Plan is carried out, about 87,000,000 acres will be receiving irrigation. This leaves two-thirds of the cultivated soil dependent upon erratic rainfall, which is commonly insufficient for maximum food production.

Any substantial improvement of these dryland areas depends on improved management to use the rainfall efficiently. The present great losses of water do double damage: the water is lost to critically needed food production, and runoff causes serious damage by soil erosion. These damages have already been very great, and, considering the needs of India, further damage is intolerable.

Contour bunding and terracing offer an immediate way to make possible tremendous increases in food production on many crores of acres of non-irrigated arable soils. The needed skills, materials, and labour are at hand. But to be successful, the bunds must be laid out accurately. "Field" bunds can be recommended only for nearly flat

land where the land enclosed by the bunds is levelled for uniform water distribution.

We, therefore, recommend that:

1. Contour bunding and terracing, especially stone terracing, should be given a top priority on soils (a) that can be shifted from rough pasture to good cropland, (b) that can be shifted from one fair crop to two good crops, and (c) that can give increases in production of 2 fold or better.

2. Since contour bunds to be effective must be laid out accurately, and since they must be continuous without breaks, except to well-prepared outlets, *legislation should be adopted that permits a majority in a village (or wider area) to vote for contour-bunding or terracing schemes that obligate all landholders in the village (or wider area).*

Mechanized Tillage *

Tractor-drawn ploughs and other tillage implements are necessary for initial or occasional tillage to permit effective use of large areas of certain very clayey or compacted soils or of those badly infested with tough, weedy plants. Proper and timely tillage of such soils can increase food production enormously.

One example among several is the black, clayey soil of the Narbada Valley and adjoining regions. After the rains stop near the middle of September, 7 to 10 days are required for the soil to become dry enough to plough. Yet sowing must be completed by October 15. The ploughing of this soil in such a short time means poor seed beds, wasteful, high rates of seeding, and low yields. Tillage with heavy machines obviates these problems and leads to increases in yield of 50 per cent or more.

Also much presently unused but potentially productive arable soil, including many village commons, have for years been heavily overgrazed and trampled. The soils are so compact that little water seeps into them. Large areas of such potential cropland cannot be ploughed with bullocks.

Many of these areas need tractor-drawn equipment only for the initial preparation; some may need it occasionally after that, or even annually if the soil is very clayey and especially if the time for preparation between crops, or between the monsoon and sowing, is short.

We, therefore, recommend that:

Heavy tractors (and other mechanized equipment) should be secured, using foreign exchange if necessary, for use where (1) soil areas will give greatly increased production and (2) cultivators are prepared to use them without significant subsidy beyond loans.

Erosion Control

Some landscapes in India are especially susceptible to serious

* See Part III, Chapter XII, for a discussion of agricultural implements and mechanization.

gullying. Badly located highway culverts, broken bunds, unprotected outlets of bunds, or any other cause of water concentration produces disastrous gullying, and subsequent restoration of the soil is exceedingly difficult and costly.

The need for erosion control to get on-site benefits to crop, grass, or forest production is clear. But erosion control is also needed in those catchment areas where the accumulation of erosion debris seriously shortens the life of water-storage reservoirs and similar large and small improvement works.

We, therefore, recommend that:

Allotments for conservation work should be made in all financial plans for public water-storage structures, and such work should be timed for early completion, and subsidies and loans for constructing tanks should be given only where the plans include measures for insuring erosion control.

Shifting Cultivation

The problems of shifting cultivation, where the cultivators have few alternative opportunities, are pressing hard for solution. Much can be done to improve these systems by applying the principles of soil and water conservation and those of crop selection for mixed cultures and also for grain crops in favoured spots.

We, therefore, recommend that:

The Centre develop a research programme for testing improvements and supplements to the existing systems of shifting cultivation.

Control of Grazing

The control of grazing is one of the most difficult agricultural and conservation problems, and also one of the great opportunities to increase food production. Recent demonstrations in India prove that such control can increase both forage and fuel trees many fold.

The Team realizes that a comprehensive educational programme is needed to make planning of controlled grazing feasible and to have laws enforced. Yet the benefits are so very great that every effort should be made to achieve such control so that grass, browse plants, and trees may have a chance to make the enormous contribution to the economy of the country which they can.

We, therefore, recommend that:

1. Enough further demonstrations should be established to permit each rural resident to see the results of controlled grazing;

2. A vigorous educational programme should be developed; and

3. Appropriate legislation should be formulated for only licensed grazing on public land.

Forestry officers should give added attention to village forest plantings, particularly of fuel trees which can release much needed manure for food production and also control erosion.

Putting More Land into Full Production

Hundreds of lakhs of acres of potentially good to excellent soil lie unused. Unused potential cropland is scattered over much of the country and represents a great resource to supply cultivators with land and to contribute to the critical food supply.

Moreover, new land development and the reorganization of village lands offer excellent opportunities for installing proper structures for water control, conveyance, and disposal that give greatly increased crop production. Field boundaries can easily be made to coincide with such structures in the planning stage. But once holdings with badly placed field boundaries are allotted, it is very hard to correct them.

We, therefore, recommend that:

1. Adequate regulations should be formulated and enforced to provide that unused or poorly used land suited to crop production be leased or otherwise made available to cultivators.

2. All plans for bringing new land into use and for land consolidation should be made jointly with experts on soil and water conservation on the basis of soil surveys.

Helping Farmers to Adopt Improved Soil and Water Practices

Fear of supposed risks causes many poor cultivators to postpone the adoption of well-proved practices. Economic evaluations of demonstrations of improved practices are thus highly significant to cultivators and lead to both wider and more rapid adoption.

Moreover, to achieve soil and water conservation, which touches every other aspect of farm land and water use, the problem of administrative and technical coordination must be solved for economic results from vast public and private expenditures. This problem is acute in many parts of India.

We, therefore, recommend that:

1. The Soil Conservation Board, in cooperation with State agencies, should work out ways to guarantee cultivators against loss from the adoption of radically different but well-proved systems of soil and water management that promise substantial increases in both yields and income.

2. Demonstrations of combinations of fertilizer use, bunding, terracing, controlled grazing, and similar practices should be accompanied by explanations of costs and returns.

3. The Centre should (a) give assistance to States for the coordination of departments dealing with agriculture, irrigation, public works, consolidation of fragmented holdings, land development and allotment, forestry, and related functions; and (b) give the effectiveness of such coordination major emphasis in determining grants to the individual States for projects in soil and water conservation or projects related to it.

Research

More basic research is needed in India in the field of soil and water conservation to help support and guide applied research and action programmes.

We recommend that *two central research stations be established to conduct basic research on national and regional soil and water conservation problems,* one in an irrigated and one in a non-irrigated area, and that funds be made available for close cooperation with the State agricultural departments, agricultural colleges, and other appropriate institutions.

Training

In order to capture the potential abundance in the soils, the necessary expansion of soil and water conservation will require greatly expanded training programmes both for professional people and for local supervisors.

We, therefore, recommend that existing facilities for such training be improved and expanded, including especially the use of combined training and work camps for diploma holders, who can be trained on the job to fill the many positions of local supervision that will be urgently needed.

CHAPTER II—BETTER USE OF PHYSICAL AND BIOLOGICAL RESOURCES

3. IMPROVEMENTS IN CEREAL PRODUCTION

Technological information is available in India to make possible immediate and significant increases in cereal production. But much more research is needed to bring both long-run and short-run production nearer to the maximum.

Methods for obtaining increased yields for cereal crops are generally the same throughout the world and are based on the following essentials: (1) adequate research personnel and facilities, (2) improved varieties, (3) high soil fertility levels and efficient fertilizer utilization, (4) plant protection, (5) proper cultural practices including weed control, and (6) mechanization.

Potential for Immediate Production Increases

The immediate potential for increased wheat and rice production lies in certain districts which have previously shown appreciable increases in yields. These districts have irrigation facilities and the farmers are anxious to apply technological knowledge in order further to increase yields. *Special consideration should be given to about 25 rice districts in various States and to special wheat districts in Punjab, parts of Uttar Pradesh, Madhya Pradesh and Bihar. In many of these specified districts yields of rice and wheat can be doubled, if the scientific approach is utilized, and all factors of production are made available in optimum quantities.*

Plant Breeding

Rice: A number of rice-breeding projects are in progress in India and work of the following type should be intensified:

1. *Breeding for strong straw.* Most of the varieties now grown have weak straw and efficient response to high soil fertility levels is not always obtained. Promising hybrids have been developed from Indica Japonica crosses which have stiffer straw and better response to high fertility levels than local varieties. These improved varieties should be made speedily available to the cultivator.

2. *Breeding for early maturation period.* There is a need for high-yielding varieties with a maturation period of about 100 to 120 days. They can be grown in areas where the water supply is limited, because they require less water than the 166-170 day maturity types. Varieties of the short as well as long maturity types are also needed which are non-sensitive to photoperiod.

3. *Breeding for disease and insect resistance.* Only slight gains have been made in these areas and the research work should be strengthened since diseases and insects are often a major limiting factor in rice production.

4. *Breeding for drought conditions.* About 65 per cent of the rice acreage is non-irrigated, and ample water is often not available for these areas. Plant breeders and plant physiologists should co-

operate on this project because basic research is needed for a scientific basis for the breeding work.

Wheat: New high-yielding, rust-resistant varieties have been developed, yet older rust-susceptible varieties are grown over large areas in certain States. Consequently, rust epidemics are a serious threat.

Wheat breeding work should be intensified in the important wheat-growing States and the Centre, giving especial emphasis to high-yielding varieties which have resistance to rust as well as other serious wheat diseases. Laboratories for testing rust samples should be enlarged so that larger samples may be tested and new races more quickly identified. *Special effort should be made to insure rapid adoption of the improved varieties by the cultivator.*

Hybrid Maize: Significant increase in yield over local varieties can be obtained with hybrid maize. *Hence a real potential for increased food production lies in the substitution of hybrid maize for local varieties, and in increasing acreage sown to hybrid maize.* Since diseases and insects pose a serious threat to hybrid maize, breeding work must be done in cooperation with the plant pathologists and entomologists.

Millets: Millets, including sorghum, represent an important group of food plant crops in India. But they have not received enough attention from the plant breeder. Recently a coordinated sorghum-breeding project has been inaugurated and *this project should receive a high priority because of a recently discovered mechanism for utilizing hybrid vigour in sorghum production.*

Plant Protection

Unnecessary yield losses are registered annually because plant diseases and insects are not adequately controlled. More equipment, such as dusters and sprayers, must be made available to the cultivator, and additional plant protection specialists must be added to the field staffs to make timely pest surveys and advise on technological phases of pesticide applications. In case of widespread outbreak of insects, control by aerial application should be emphasized.

The need for close cooperation between plant protection personnel and research centres is necessary. Timely refresher courses for plant protection personnel are important, since new plant protection materials are continually being developed, and up-to-date information is necessary on selectivity, timing, rate and number of applications, and toxicity hazards.

Mechanization

Mechanization, discussed in a subsequent part of this report,* is a significant means of increasing crop production. The use of machine power to supplement animal power for better and more timely soil preparation, and the use of better designed harvesting equipment to reduce losses in yield and grain quality during the harvesting period can increase cereal production in many areas. *A strong engineering department is needed where present equipment can be improved in*

* See Part III, Chapter XII.

design, where new equipment can be developed, and where imported equipment can be checked for adaptability.

Special emphasis should be given to the improvement and design of mechanical equipment which can be used for weed control. For example, the rotary weeder, used extensively in rice cultivation, and similar equipment, should be improved in design.

Culture Practices

"Japanese method" of paddy cultivation. Experiments show that 60 to 70 per cent (7 maunds per acre) of the increase in production from the "Japanese system" of paddy cultivation is due to the use of organic and inorganic fertilizers. The yield increases associated with cultural practices alone are about 2 maunds per acre. It should be understood that *the Japanese method can and should be adopted in areas under irrigation but that a high priority must be given to the use of commercial fertilizers in order for the system to result in high yield increases.*

Fertilizers. As indicated in the preceding section, organic manures and chemical fertilizers are complementary, and since organic manures alone cannot be relied upon to achieve production goals, a high priority must be given to commercial fertilizers if proposed cereal production goals are to be met.

Improved Varieties

The acreage of grain crops planted to improved varieties is estimated at only 15 to 20 per cent of the total. This acreage must be substantially increased through (1) an efficient seed multiplication programme and (2) a vigorous educational programme to convince cultivators of the need and economic advantage of planting improved seed. Full benefits from other improved practices (such as irrigation, application of fertilizers and plant protection) cannot be realized unless improved varieties are grown. There is a critical need for wider testing of new varieties to determine the areas for which they are suitable. Regional State tests should be more widely employed and should include varieties from all States, Centre, as well as promising importations. Testing of foreign varieties should be encouraged for all crops.

Crop Production Research

Despite the fact that research scientists in India have made notable contributions, it must be stated that *there are not enough trained scientists in any field of crop production to satisfy the requirements for a true scientific approach to increasing crop production.** Much more emphasis must be placed on applied research in order that the cultivator's production problems can be solved. Strangely enough, *because of low salaries and unrealistic promotion and retirement policies, the full potential of the available scientists is not being realized.* In certain State research centres library facilities are not sufficient to allow research workers to keep abreast of the world scientific literature.

* Programmes for post-graduate research in this field must be strengthened and expanded. Existing personnel and facilities for post-graduate work are inadequate. For general discussion of this subject see Part III, Chapter V.

In view of the shortage of research personnel and equipment, we believe that more progress could often be made if research talent and facilities were concentrated at certain centres to permit a cooperative approach among technicians with varied training. For example, in the development of improved varieties, much more rapid progress can be made if there is close cooperation between the plant breeders, plant pathologists, entomologists, agronomists, geneticists, and plant physiologists. Closer cooperation between the States and between the States and the Centre would also result in greater and more efficient research output.

CHAPTER II—BETTER USE OF PHYSICAL AND BIOLOGICAL RESOURCES

4. THE MULTIPLICATION AND DISTRIBUTION OF IMPROVED SEEDS*

One of the most economical means of increasing crop production is through high-yielding crop varieties. Since improved varieties have no value until used by the cultivator, *a vigorous effective seed multiplication and distribution programme is an absoluate necessity to increase food production in India.*

Seed is a basic crop cost, present whether good or poor seed is used. Therefore, unstinted effort is necessary to replace poor seed with improved seeds. Yet, the raising of crop-yield potential can be fully realized only when the cultivator uses improved seed in a soil of high fertility together with other improved practices.

The Need for Seed Specialists

In meeting the urgent need for improved seed, India has assigned responsibility to the extension workers who are loaded with many other duties. Progress has been made, but extension workers, especially at the block and village level, lack adequate training and time and are failing to make satisfactory progress both with respect to seed supply and seed quality. Demands for seed services will grow, as will the job of seed inspection and shopkeeping. *The needed progress in improved seed multiplication and distribution can only occur under the leadership of competent seed specialists.*

A cadre of seed specialists should, therefore, be trained and recruited as quickly as possible. They are needed at the Centre, State, district and block levels. Centre and State specialists should be botanists, preferably with post-graduate study and with demonstrated competence in the field. District and block seed specialists should be college of agriculture graduates, with work in botany and agronomy and with additional in-service training.

Education, Supply and Quality Control

Three distinct aspects of a successful improved seed programme are education, seed supply and quality control (or certification). All of these are now handled as a combined activity by State departments of agriculture and community development. We believe that these three aspects are incompatible in a combined administrative setup. Each aspect impinges on the other with the result that the vitality needed in each part of the programme is lacking, and progress suffers.

> We recommend that (1) village, block and district extension workers should be responsible primarily for improved seed education, (2) the State departments of agriculture should be responsible for seed certification, and (3) cooperative and private growers should be encouraged to assume the role of supplying improved seed. In the interim, as recommended in the section of the report on extension,** the block cooperatives officer should assume primary responsibility for improved seed supply. In

* A fuller discussion of this subject is included in Part III, Chapter X.
** See Part III, Chapter VI.

this transitional period, it is important that improved seed programmes do not suffer.

Seed Certification Standards

In improved seed schemes, there is presently a lack of uniformity among States and within States as to (1) improved seed quality standards, (2) the nomenclature for improved seed, and (3) seed multiplication procedures. This results in great variability in seed quality (State Governments are handling far too much seed of poor quality), and confusion and failure to take remedial steps.

If seed improvement schemes are to be successful, the Centre and State Governments should develop and enforce uniform seed certification standards of all crops.

Maintenance of Varietal Purity

To reduce roguing costs in seed increases, and to improve genetic purity of seed for the cultivator, a continuing supply of 100 per cent pure Breeder seed is needed. To maintain varietal purity, seed multiplication procedures must be adapted to the type of crop—self or cross fertilized or hybrid. *The plant breeder must maintain recurring supplies of pure Breeder seed of improved varieties, and seed multiplication methods must be employed which will maintain varietal purity in seed increases.*

Importance of High Quality Seed

More and more seed of improved varieties is used, yet the cultivator fails to get satisfactory yield increase because seed schemes do not provide enough good seed which is genetically pure, of high germination, free from weeds, other crops and seed-borne diseases. Very little seed is given even a rudimentary germination test, and since standard seed-testing procedures are not used, little is actually known about the quality of seed handled under such schemes or of that planted by the cultivator. Seed legislation to govern commerce in seed has been enacted in only a few States.

Effective steps should be taken to upgrade the quality of seed included in improved seed programmes. As an aid in accomplishing this, the States should establish and operate modern seed-testing laboratories and enact suitable seed laws.

Stock Seed Farms

Planned multiplication of high quality stock (Foundation) seed is essential. Decentralization of Foundation seed production for self-fertilized crops at the block level is sound only if (1) fully competent management is available, and (2) farms can be efficiently operated. Lack of enough seed specialists, plus need for mechanization, requires deviation from present rigid seed farm sizes, which prevent effective use of staff and equipment. Government-owned land, used for seed production, is often not managed for highest yields of top-quality seed.

We recommend that Goverment stock seed farms should be established only at the rate at which competent manage-

ment can be trained and recruited. Fewer farms of larger size will more fully utilize competent managers and equipment.

Improved Seed for the Villager

Multiplication of the last stages of seed increase (Registered and Certified) in each village presently taxes the time of the VLW and of the block agricultural officers who do not have seed training. The result is a supply of seed of questionable quality and in inadequate quantity. Ultimate use of improved seeds is left to slow, uncertain, natural spread within the village.

Increased production of improved seed should be concentrated in each block in one, or at the most two, selected "seed multiplication villages." These villages should receive special technical assistance, fertilizer allocations, plant protection measures, etc., to facilitate maximum production of high-quality seed. Wherever feasible, improved seed multiplication should also utilize the well-managed middle or larger sized farms.

An excessive number of improved varieties clutters listings in many States. This dilutes the multiplication and distribution effort. Some varieties are superior; far too many are mediocre. All too frequently States fail to utilize the best varieties evolved in other States or the Centre. *An all-India scheme for variety testing for all important crops, adapted to regions and crops, should, therefore, be inaugurated immediately under the leadership and financial assistance of the Centre.* To get maximum value from coordinated variety testing, *"Variety Release Committees" should be established in Centre and States to pass on all varieties*, new and old, which are to be included in seed multiplication schemes. It is vital that only the best varieties be included in State seed schemes regardless of origin. Data on disease resistance and other desirable characteristics, determined in well-equipped laboratories, should also serve as criteria in accepting varieties. Centre scientists should be represented in State seed committees in an advisory capacity.

Merchandizing of Seed

Seed merchandizing, including attention to seed quality, has not received enough attention in seed schemes. This deficiency is fast becoming the major deterrent to successful improved seed programmes. India does not now have a seed industry to take leadership in seed merchandizing, or to engage in either seed multiplication or distribution. As a result, local extension personnel are increasingly devoting their time to inadequately organized seed distribution schemes, often at the expense of the educational programme.

All possible speed should, therefore, be used in developing supply cooperatives, and where feasible private enterprise, to assume major responsibility for Certified seed distribution along with other agricultural supplies.

Special Crops

India with its diverse soil and climate has great potential for developing specialized seed crops—forage, green manure, vegetables, etc.

An all-India coordinated research and development programme should be inaugurated to discover and put to use the most suitable areas for the multiplication of pure high-quality seed of improved varieties of certain crops, including vegetables.

Maize *

By using the world-wide pool of maize genetic stocks and knowledge in breeding, culture, plant protection and seed multiplication, *India can in 5 to 7 years make more progress in increasing its maize yields than the U.S.A. made in 20 years.* New high-yielding hybrids with improved disease resistance and good agronomic characters should be used to extend high-yielding culture of maize to new areas and in certain areas to more than one crop season.

> *We strongly recommend, therefore, that India embark immediately on a vigorous hybrid maize seed multiplication and distribution programme.* It is essential that this scheme be developed on an all-India coordinated basis, with Centre financing and with policy to be established by a State-Centre Board. We believe that an autonomous corporate structure free to organize and carry through a successful hybrid maize programme can best do this job.

Such a coordinated scheme will also fit the development of hybrid sorghum seed.

Storage

Storage to maintain high planting value of improved seeds, particularly in the hot humid season, is a major problem. Heavy losses may occur in large central seed godowns as well as in the villages. It is imperative that the accumulated knowledge of seed storage for tropical climates be fully applied in India, both as a type of storage and protection from insects, rodents and fungi.

Progress Evaluation

Progress in improved seed schemes can be ascertained by determining the proportion of the acreage planted to recommended varieties. Such data has in the past often been improperly determined and reported. Grossly misleading data is less useful than no data. Hence *only statistically sound methods of reporting acreage planted to improved seeds should be employed.* Such determinations should also include consideration of seed quality.

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* A fuller discussion of this subject is included in Part III, Chapter X-A.

CHAPTER II — BETTER USE OF PHYSICAL AND BIOLOGICAL RESOURCES

5. LIVESTOCK DEVELOPMENT AND FOOD PRODUCTION

Animals use land and other resources which could be used in producing food grains and fibres urgently needed by human beings. The problem, then, becomes one of minimizing competition between people and animals for products of the land.

The objective clearly should be to improve the efficiency of draft power and to increase the quantity of animal products without using more land, or, better still, to produce more power and more animal products from less land than is now being used for these purposes. In any event, the contribution to increased food production can be made only by means of programmes which are based upon sound economic principles and scientific findings.

India has the technical competence and the animal and other resources necessary to achieve this objective. The overriding question is whether these resources will be mobilized in such a way as to produce the desired results. Unless all efforts and resources are put where they will really count, i.e., in the villages on projects which will result in better feeding, management, breeding and marketing, contributions to increased food production will be of little consequence.

Too Many Cattle

There is widespread recognition, not only among animal husbandry officials and technicians, but among citizens generally, that *India's cattle population is far in excess of the available supplies of fodder and feed.* The bovine population of India is estimated to be 203 millions, of which 155 millions are cattle and 48 millions buffaloes. This is one-fourth of the world's total, and more than the bovine population of any other country. Only Denmark has more cattle per square mile than India. At least one-third, and perhaps as many as one-half, of the Indian cattle population may be regarded as surplus in relation to the feed supply. *The problem is being accentuated greatly by a substantial annual increase in cattle numbers.*

Authentic figures are not available upon which to base a reliable estimate of the total loss to the nation because of cattle which neither work nor produce milk. *But it is known, for example, that more dung is produced when a given quantity of feed is consumed by one animal than when it shared by two animals.* The magnitude of the loss to the nation from feeding useless cattle and buffaloes may best be illustrated, however, by calculating the quantity of milk that would be produced if the feed now being consumed by such useless animals were added to the rations of milch animals whose maintenance requirements are already being provided for. If this transfer of feed were possible, it is reasonable to assume that at least one additional pound of milk per day could be produced as a result of eliminating one useless animal. Thus, for each animal eliminated, 365 pounds of milk would be gained annually. This quantity of milk, if valued at 13 annas per seer (the

* A fuller treatment of this subject is found in Part III, Chapter XI.

price now being paid at many points in India), would be worth Rs. 148. *On this basis, the total amount gained annually by the nation from eliminating useless cattle and buffaloes would exceed Rs. 70 crores. Of perhaps even greater significance than the monetary gain is the fact that each pound of additional milk thus made available would provide the suggested daily nutritional allowance for one Indian child.*

Programme for Reducing the Number of Cattle

That a comprehensive programme for reducing the number of cattle, regulated by Government, would be the quickest and most effective way to bring cattle numbers and supplies of fodder and feed into balance, is generally recognized, even by many who would oppose such a programme for reasons of sentiment. Development of such a programme, however, is complicated by the ban on cattle slaughter, which has resulted in large numbers of stray cattle. These useless animals not only are responsible for the imbalance of cattle numbers and feed supplies, but are a serious menace to crop production. This situation is recognized by citizens generally and is a subject for comment in newspapers as well as in technical reports and publications on animal husbandry.

That there is a changing trend in the attitude toward cattle slaughter in India is revealed in numerous statements, resolutions and reports published in official documents. The forthright statement made by Prime Minister Nehru, during the debate on the Indian Cattle Preservation Bill in 1955, has been brought to our attention by many scientists and professional leaders. Nor do technical personnel concerned with the problem hesitate to express their opposition to the ban on cattle slaughter. For example, a committee appointed in 1954 to study the question concluded that "a total ban on cattle slaughter would not be in the best interests of the country."

Opposition to the ban on cattle slaughter also was voiced in a resolution adopted in 1957 by members of the Animal Husbandry Wing of the Board of Agriculture and Animal Husbandry in India. Again, in 1957, the results of a questionnaire circulated to agriculturists and human nutrition specialists throughout India revealed that 59 per cent of the respondents believed in planned slaughter for the elimination of useless cattle.

Modifications of the ban on cattle slaughter by the States so as to permit the economic utilization of stray and useless cattle would contribute significantly to the attainment of the objective for animal husbandry programmes set forth in the Second Five Year Plan: "...to increase the supply of milk, meat and eggs, a greater consumption of which is very essential in order to balance the present customary diets, and to provide efficient bullock power for agricultural operations in every part of the country."

Unless problems associated with excessive cattle numbers and the attendant shortage of feed supplies are dealt with realistically, contributions of animal husbandry to increased food production will be extremely difficult, perhaps impossible. To a Westerner, a realistic approach to the solution of these problems would have to include a cattle slaughter programme. Yet one who accepts an assignment to advise India on such matters must keep the doctrine of *ahimsa* in

mind and be prepared to analyze problems within the limitations of that doctrine. Unless he is prepared to do this, it perhaps would be better he not accept the assignment.

This report and the recommendations contained herein have been prepared in the belief that progress can be made within the limitations imposed by the doctrine of ahimsa, along with a deep sense of obligation to point out how the ban on cattle slaughter complicates the problem of increasing food production. Furthermore, a study of food production of India manifestly would be incomplete without some consideration of the cattle slaughter question. *This should not be taken to mean that it is necessary for outsiders making such a study to take a position for or against cattle slaughter in India. The question is one which can be dealt with by India alone under her own political and socio-religious systems.*

Recommendation for Reducing Cattle Numbers

While an outsider may properly conclude that he should leave the question of cattle slaughter for India's political and professional leaders, he also may just as appropriately feel that it is within his province, when his advice on animal husbandry is requested, to recommend other means of reducing the number of cattle and of controlling the rate of reproduction. *With this in mind, the following practices and procedures are recommended:*

1. *A graduated tax on cattle which would make the maintenance of useless cattle a burden on their owners;*
2. *Compulsory confinement of all bulls kept for natural service;*
3. *Mandatory castration of all young bulls not required for breeding;*
4. *Compulsory sterilization of surplus cows and heifers; and*
5. *Measures to control open grazing.*

Dessicating Plants

Failure to make use of the carcasses of fallen animals is an enormous wastage of materials which could contribute significantly to increased food production. Meat meal, produced from such carcasses, is a source of high-quality protein and an essential component of balanced poultry rations. Bone meal, animal by-product fertilizer, hides and fats are other valuable materials which can be salvaged from animal carcasses.

It is recommended that dessicating plants, fully equipped to process animal carcasses, be established on a sub-district, district or regional basis and that incentive payments be made to owners who bring fallen animals to these plants.

Poultry Production

Poultry production has a tremendous potential in India (1) as a village enterprise, (2) as a backyard project in urban areas, and (3) as a commercial business. This potential attests to: (1) the efficiency with which poultry convert feedstuffs into human food, (2) the small investment required to get started, (3) their suitability as a family

enterprise, (4) the small area required, even for large units, and (5) quick financial returns.

India's potential in poultry production will not be reached unless encouragement, including Government aid if necessary, is given for the production of balanced poultry feeds. Facilities will need to be provided for assembling, mixing and distributing such feeds.

It is strongly recommended that steps be taken immediately to encourage a marked expansion of the poultry industry.

Integration of Livestock Production and Crop Production

Substantial increases in the production of milk, eggs and poultry are possible in the next seven years. To obtain these increases will require much more effective integration of livestock production and crop production than has been attained heretofore in India. Moreover, technical personnel in animal husbandry, agriculture, cooperation, community development and related subjects, instead of working alone, will have to work together as a team. *There must be one programme for animal husbandry, including the all-India key village scheme, mixed farming projects and dairy development, irrespective of where the work is done or who does it.* For example, an intensive programme of cattle development may be introduced immediately in all villages from which milk is collected for urban consumption.

It is recommended that the Indian Council of Agricultural Research evolve a plan for shaping and carrying out animal husbandry projects. This plan should stress (1) the interdependence of livestock production and crop production; and (2) coordination and teamwork among agencies and technical personnel concerned with (a) production and use of fodder and feed, (b) the improvement of livestock, and (c) the marketing of milk, eggs and poultry.

Over the long term, there are certain other activities which need to be started to insure sustained future increases in food production. These include: (1) a constructive programme of grassland improvement and management; (2) applied research on practical animal husbandry problems; (3) basic and applied research in animal nutrition; and (4) a country-wide marketing organization linked to mixed farming.

PART THREE

PLANNING FOR AN ABUNDANT AGRICULTURE

PART III

CHAPTER I — THE ROLE OF COOPERATIVES IN EXPANDED FOOD PRODUCTION

The individual cultivator is incapable, by himself alone, of breaking loose from his poverty-stricken status. *Cooperative effort is required to break the strangling grip of the money lender and traders on the marketing, supply and credit functions in the villages. Central and State participation is necessary in the form of loan advances to supplement the share capital of the primary societies, loans and subsidies for the construction of required godowns and other physical structures, and staff services for education and managerial assistance during the early stages.*

1. THE SITUATION TODAY

The oldest cooperatives in India are the agricultural credit societies which have been in operation since 1904. At the end of 1956-57 there were 161,510 of them but they extended only 67.3 crores of rupees of credit. This was less than 10 per cent of the total agricultural credit used by the cultivators.

We are informed that many of these societies are dormant and are, in fact, credit societies only on paper. Others are composed of members of a single family. Some societies have performed a very useful service but these are relatively few. For the country as a whole, credit societies have never been important in the agricultural credit field. The primary sources of credit for the cultivators in most parts of India are the village money-lenders, traders, and other individuals.

Many reasons have been given for the failure of these cooperative societies to become important, but the most frequently mentioned were the following: (1) selfish interests often got control of the societies and ran them for their own benefits, (2) inadequate capitalization, (3) inadequate supervision and assistance, (4) "red tape" in getting loans, (5) slow service, (6) too low individual loan limits leading to inadequate financing of the cultivator, (7) tenants could not borrow because pledge of land was required, (8) unlimited liability which had the effect of keeping out the financially strong. It is thus evident that the societies have not provided an adequate and dependable source of credit to the cultivators. This fact was clearly set forth in the report on the All India Rural Credit Survey conducted by the Reserve Bank during 1951-52 and published in December 1954. As a result of the facts reported by that survey, there was developed "The Integrated Scheme of Rural Credit" which was embodied in the Second Five Year Plan.

Some of the more important features of that scheme were:

(a) The State would enter into partnership with cooperative societies. This did not, however, extend to the small primary credit societies.

(b) Limited liability in credit societies was favoured over unlimited liability of the Raiffersen pattern.

(c) Societies were favoured which were large enough to employ a full-time manager and have potential for an adequate

volume of business to build financial strength and viability. It was not intended that such societies should cover so large an area as to be difficult for the cultivators to contact.

(d) A shift of emphasis was recommended from land to crops as a basis for production loans.

(e) Credit and marketing would be linked by having borrowers sign agreements to market through marketing societies with which the credit society would be affiliated.

(f) Credit should be extended in kind as far as possible. (Affiliation with marketing societies, which usually distribute production supplies, also was mentioned as important in this connection.)

In line with these proposals for the so-called Integrated Scheme for Rural Credit, there were approximately 6000 "large size"* societies organized by the end of 1958-59, and substantial progress was being made on other cooperative fronts. The cooperative bank structure was strengthened by the organization or reorganization of 16 State and 335 Central cooperative banks.

1200 primary marketing cooperatives were also organized. These cooperatives were organized to perform both the marketing and supply functions for the credit societies and individual cultivators in their area. Most of these cooperatives have or are to have a godown—either owned or leased.

But the organization of large-sized societies was stopped by the resolution of the National Development Council on cooperative policy adopted at its meeting on November 8 and 9, 1958. In that resolution "The Council considered that for the development of cooperation as a people's movement, it was essential that cooperatives should be organized on the basis of the village community as the primary unit, and that responsibility and initiative for social and economic development at the village level should be placed fully on the village cooperative and the village panchayat."**

The Council further recommended that the States review their programmes of cooperative development and formulate new programmes to be implemented during the last two years of the Second Plan programme. Following the adoption of this resolution by the N.D.C., a top-flight committee was appointed to consider ways of implementing the resolution.

Thus India has had considerable experience with various approaches to cooperative development at village level but she has not, as yet, found a basis for a programme on which all can agree. Until this is done, India can accomplish little in this phase of cooperative development.

We find that there is considerable inertia in all sectors of the cooperative movement today. Our inquiries into the reason for this

* These societies were designated as "large sized" to distinguish them from the former "small sized primary societies" usually serving a single village.

** Report of the Working Group on Cooperative Policy—Government of India, Ministry of Community Development & Cooperation, Department of Cooperatives. January 1959.

has brought many different responses but most frequently mentioned are: administrative "red tape," the multitudinous requirements imposed by Governments before societies can be registered and State and Centre funds used; fragmented responsibility for educational and promotional work on cooperatives; and shifting policy at the national level.

Government Help

The Second Five Year Plan states that "the objective is to enable cooperation increasingly to become the principal basis for the organization of economic activity." To achieve this status for cooperatives, the Second Five Year Plan envisages "that the State should enter into partnership with cooperative institutions at various levels." It is stated further that "such financial partnership would provide additional strength to cooperatives and make available to them in fuller measure assistance and guidance from the Government."

In order to facilitate partnership of the State in cooperatives, the Reserve Bank established a National Agricultural Credit (long-term operation) Fund. To this fund, the Bank made an initial contribution of Rs. 10 crores, and provided for additional contributions of Rs. 5 crores per annum so that by the end of the Second Plan, 1960-61, the Fund would have a capital of Rs. 35 crores.

Further, a National Cooperative Development and Warehousing Board was established on the 1st of September, 1956. This Board does not deal directly with cooperatives but provides assistance to State Governments so that they in their turn may effectively support the cooperatives. For this purpose, the Board has set up two funds: The National Cooperative Development Fund and the National Warehousing Development Fund.

The National Cooperative Development Fund is used for advancing loans and granting subsidies to State Governments to enable them to subscribe to the share capital of cooperative societies or for otherwise financing cooperative societies.

The National Warehousing Development Fund is applied for:

(a) subscribing to the share capital of the Central Warehousing Corporation;

(b) advancing loans to State Governments for enabling them to subscribe to the share capital of State Warehousing Corporations; and

(c) advancing loans and granting subsidies to a Warehousing Corporation or to State Governments for promoting the warehousing and storage of agricultural produce.

The Board was expected to sanction financial assistance of Rs. 22 to 23 crores, which represented the Centre's share of assistance for cooperatives and warehouse development schemes included in the Second Plan. However, it is estimated that only Rs. 19.9 crores will be used.

In addition to the assistance given by the Reserve Bank and the National Cooperative Development and Warehousing Board, the State Governments provide assistance of various types, including subsidies for management, supervision, and other purposes, as well as loans and share capital. There is considerable difference in the manner

in which this assistance is given and administered, however. In some States, requirements are so rigid as nearly to defeat the purposes for which assistance is given.

Many of the requirements and restrictive regulations imposed upon cooperatives are a carryover from the pre-independence period. Others are imposed because of some sad experience with unfaithful performance of duty by government officials, boards of directors and employees of cooperatives. While these experiences are not general, they have affected the whole of the movement by causing such apprehension on the part of responsible government officials that unrealistic requirements are imposed. Among the most stifling are requirements in some States demanding direct participation in day-to-day operations by government employees.

Government assistance to cooperatives must be given in a timely and helpful manner and with confidence if it is to contribute the maximum to the development of cooperatives. This is not to say that Government audit or inspection is not necessary. It must be maintained and strengthened in many States. Cases of bad faith must be dealt with firmly, impartially and without delay. Direct participation of Government employees in operations, on the other hand, contributes to delay and frustration and, if continued, may cause the whole system to fail.

2. MAKING COOPERATIVES WORK

Requirements of a Successful Cooperative

A cooperative organized to perform economic functions is a business organization. If it is to make a significant contribution toward increasing India's food production, it must be built upon sound business principles. It must have sufficient capital strength to provide adequate working funds to fulfil the purposes for which it was established. It must have sufficient income to pay necessary operating expenses, including the cost of competent management.

There are other requirements for a successful cooperative. It must perform a needed function better than it is presently being performed. It must be organized upon a basis that permits successful operation. In addition to capable management, it must have capable and informed directors; an informed and loyal membership; and proper audit, inspection and supervision.

No single blanket pattern of organization can be prescribed to fit all cooperatives in all localities and conditions. Although the village is the basic social unit in rural India, there are great variations between villages as to size and social structure, relative economic status, availability of markets, type of agriculture conducted, etc. These and other variables make it necessary that cooperatives be built to fit the circumstances existing in the specific area to be served.

The structure of a cooperative society is not so important as the results it achieves. Fundamental principles of cooperation must be adhered to, but the type of functions a society performs, the nature of its membership and the number of villages served will have to be determined by the circumstances found in each situation.

As a society grows in strength and stature its structure may logically and necessarily be changed in order to better serve its area. Thus the original structure may not be the permanent one.

This flexibility is of great importance in a developing nation, because as the rural areas develop economically and socially the people will begin to look beyond their village walls and the boundaries of their lands. New problems as well as opportunities will be revealed and new social and economic groupings will develop.

This will be brought about by improved communication and transportation, by the cultivators purchasing more of their production requirements and selling more of their produce in the markets, by their joining with the people of other villages to develop their lands cooperatively and perform mutually beneficial services, and by their being better educated and informed. *The people's cooperatives must not be rigid in structure but must be able to adapt to the future as well as the present.*

3. THE PEOPLE IN COOPERATIVES

Cooperative Leaders

The future of the cooperative movement in India depends upon the people who lead, direct and manage it. In addition to many qualified people in Government, India has in the cooperative movement capable, well-informed and dedicated people, who are not in Government. This non-official group can provide informed and practical information which is indispensable to the development of sound and practical policies and plans. Therefore, we believe that the counsel and advice of qualified and dedicated non-official cooperators should be sought when considering either State or national policy or plans to implement policy.

Unless non-official leadership is recognized and developed, cooperatives will be led and dominated by Government. This is not India's objective as we interpret her plans. Obviously, if there are any non-official leaders who have selfish designs they must be weeded out, or they will cause the whole movement to fail and the whole economic development programme will suffer a severe blow.

Auditors and Inspectors

The attitude of auditors and inspectors is important. They must approach audit and inspection with a helpful attitude rather than a strictly critical one which places emphasis upon minor details. In any new development, honest errors in judgment are bound to occur. If these are magnified and responsible employees severely criticized for such errors, initiative is stifled and the programme suffers. The State registrars can be of material assistance to the cooperative movement by developing in their employees this philosophy of assistance and encouragement, and by stressing the necessity for them to distinguish important from non-important infractions of rules and errors of judgment. There must, however, be no compromise with dishonesty, selfish designs, or general incompetence.

Personnel Training of Officers and Employees

The flexible approach to cooperative development requires a concentration of training in the requirements of successful operation. Cooperative leaders and officials at all levels, and especially at the village level, must be trained in those matters so that they may know how to appraise the probable chances of success of any cooperative and also know how to organize or reorganize a cooperative on a basis which will be conducive to successful operation.

The Government of India and the Reserve Bank are to be commended for the creation of the Central Committee and the establishment of training schools for officials and employees of cooperatives. The All India Cooperative Union should also be commended for their work in cooperative training for "non-officials."

As we reviewed, however, the syllabi for training of officials and employees, we noticed that for the intermediate and subordinate personnel and for extension service personnel, time is devoted to the teaching of agricultural subjects, but that no such training is given to senior officers.

It is our view that it is especially important for the senior officers of all cooperative societies, cooperative departments and Cooperative Banks to have at least enough training in agriculture to develop a full appreciation of the many agricultural problems in India and a greater knowledge of their possible solution. The extension of credit upon the basis of expected crop yields and repayment ability requires a great deal more agricultural knowledge than the extension of credit upon the basis of land or other security. Similarly, as more scientific knowledge is applied to agriculture, the managers of cooperatives handling supplies and marketing crops must have a basic knowledge of agriculture and the cultivators' needs.

If cooperatives are to be the principal economic institutions in agriculture, there will continue to be a great demand for capable and trained employees. *The agricultural colleges should develop curricula designed to give the proper basic training for future employees of cooperatives.* Graduates in such a course of study would require specific training in their selected fields and refresher training from time to time. The training facilities provided by the Central Committee would be appropriate for this.

Training at the Village Level

The rural people who are or will be the members of these cooperatives must be taught the fundamentals of cooperative action and what they can and cannot expect their cooperatives to do for them. They must also know what their responsibilities are as members. Cooperatives must be developed by intensive educational and promotional work at the village level. They cannot be developed by edict or policy pronouncements.

We have found very little of this essential educational work being done in India. Therefore, we strongly recommend that the registrars for cooperatives in the various States provide sufficient personnel in the extension blocks to do concentrated educational and promotional work on cooperatives. These people should have the re-

sponsibility for this assignment but should work in cooperation with the Central Cooperative Banks, and supervising unions where they exist. They should have had training in the principles of cooperation and in extension methods, and should not be given any responsibilities for audit, inspection or other functions of the registrar.

Government-Appointed Directors

In appointing directors to boards of cooperatives in which Government has advanced funds or provided subsidy, it is our opinion that the number of such appointments should be limited to a minority of the board, and they should be local people who have a real interest in cooperatives and are familiar with the requirements of the cultivators. Their terms should not exceed five years, after which the entire board should be elected by the members. A limitation on the number and term of government-appointed directors should also apply to cooperative banks and district and apex societies as well as to primary societies.

If two or more are appointed, their terms should be staggered so that they would not all terminate the same year. In this manner the local people would gradually assume more control. Only by giving local people opportunity and responsibility can leadership be developed. We believe that it is especially important that the cooperative banks have their board members elected as soon as possible, by the primary societies and other cooperatives served. We were informed on numerous occasions that cooperative banks were more urban than rural minded. Where this situation exists, it should be changed as soon as possible.

Managerial Assistance

A competent manager is a requirement of a successful cooperative. In the developmental stages it will be impossible to find capable managers in some of the villages. Where this is the situation and *only* in this situation, we believe that it may be an advantage to the movement for a qualified government employee, if requested by the board of directors of the cooperative, to be deputized to the cooperative for a limited period, not exceeding 3 years.

During this period he would be fully deputed to his new job, and would be accountable only to the board of directors of the cooperative. Such a manager would have responsibility of training someone to assume management responsibilities by the termination of his deputation.

In this connection it must be realized that all employees of the registrar or other departments of Government are not qualified managers of cooperatives. Extreme care must be taken in the selection of any such employee as manager. *Management is so important that, despite the urgency of the situation, no cooperative should begin operations until the board is confident that they have a qualified man who will command the confidence of the people and be able to build the organization.*

4. COOPERATIVE INSTITUTES AND COOPERATIVE UNIONS

If cooperatives are to develop as a "people's movement" they should have representation at all levels of Government when matters

affecting cooperatives are under consideration. It is in this area, and in the area of education and research on cooperatives, that we believe the cooperative institutes and unions can make their greatest contribution. The unions should work hand-in-hand with the men in the extension blocks who have responsibility for educational and developmental activities. They should help plan and execute educational and developmental programmes. This work may, in fact, be delegated to them by the State, in certain areas where they are capable of doing the job. Delegation of the work to cooperative institutes and unions would not, however, relieve the State of its own responsibility for educational and developmental activities.

The institutes and unions are now performing many valuable services to cooperatives. They are articulate in regard to proposed policies and programmes affecting cooperatives and they are doing important educational and developmental work.

Their work should be continued and expanded. However, we believe they could make an even greater contribution if they were entirely supported by cooperatives and could be relieved of having to ask the Government for support. Only when they reach this position can they be the completely unfettered representatives of cooperatives. During this developmental period, their work is so important that Government assistance is, in our opinion, justified. But they should try to become free of Government support as soon as possible. This is in conformity with the policy we recommend for cooperatives.

5. THE PRIMARY SOCIETY

If cultivators are going to produce more food, they will need more credit, more production supplies such as fertilizers, improved seeds, agricultural chemicals, etc. They need also an improved marketing system to give them more assurance that they will benefit from greater production.

These are all requirements of cultivators, whether they are landlords, tenants or owner-operators. The requirements are closely related and are complementary one to the other. Thus they can all logically be handled by a single primary society operating at the village level. Usually a primary society in India can perform all these functions together better than it can perform a single function. On this point there is general agreement. Our discussion of primary societies is, therefore, based upon the assumption that their original functions will be to extend credit, distribute supplies and assist members in the marketing of their products.

6. EXTENDING CREDIT THROUGH THE PRIMARY SOCIETY

An adequate, dependable and timely credit service at reasonable cost is a prime requisite of rural development and increased agricultural production Over 85 per cent of the credit provided to cultivators today is from money lenders, traders and other individuals at generally exorbitant rates of interest. These are certain conveniences in these traditional credit systems, however, that must not be overlooked when trying to provide cultivators credit at reasonable cost through cooperatives.

The credit from money lenders is convenient; it is usually not secured; it requires no waiting period; and no formal papers are involved. There is frequently no rigid due date for repayment or requirements as to purpose. Although a primary society cannot expect to match the money lender in all the above aspects of lending, it must offer some advantages which the money lender cannot or will not give, to compensate for the convenience and informality of borrowing from him. It is the opinion of the Team that any credit system which will attract the cultivators, really benefit them and increase production must provide adequate credit, be dependable and timely, and be reasonable in cost.

In the following discussion, we point out what we believe to be required of Government and the cultivators, if this kind of credit system is developed.

Government Financial Assistance to Primary Societies and Cooperative Banks.

We believe that if primary societies are to become important in the extension of credit in India, the State Governments must advance loan funds to supplement the capital investments of the members to the extent necessary to provide a capital base adequate to support the complete borrowing needs of cultivators. The Reserve Bank can then provide the necessary loan funds through the cooperative bank system so that no society would be forced to deny a loan or give an inadequate loan because it did not have adequate resources.

We have noted that present plans do not provide for Government advancement of funds to the smaller primary societies. We realize the great administrative problem that would be encountered by advancing funds to such a large number of these societies. But *we are unable to see how a primary society will be able to provide the services (especially the credit services) needed in a village without Government advances to supplement the capital of members.*

The present policy is apparently aimed at maximizing member investment. Although we recognize the importance of stimulating capital formation in the rural sector, we believe that the first step toward increasing capital formation is to provide an adequate credit system which will assist the cultivators to increase production and income. There will then be a larger source from which savings for capital purposes can be drawn. The extension of further credit, especially medium and long term, will aid in holding these savings in the rural sector and contribute further to capital formation.

In the beginning, the Government's advancement of funds to supplement the capital of societies may constitute the major portion of the total investment. But if members are required to maintain their investment in an amount equal to some appropriate proportion to their loans (an investment of 8 or 10 rupees for each 100 rupees or portion thereof of the loan is often mentioned), the capital of the societies will develop as their volume increases.

The State laws now require that 25 per cent of the net earnings of any society be placed in reserves and invested in approved securities. The remainder are available for the payment of dividends on capital stock. We are informed that few societies today have net earn-

ings sufficiently large to pay dividends after meeting the 25 per cent reserve requirement. But their earnings will grow if they expand their services and they will have to decide whether to pay dividends or retain the earnings in the business.

We are of the opinion that all net earnings should be kept in the business until the Government loan advances are paid or nearly paid.

Because of the small holdings of individual cultivators, a modest dividend on stock would be of little value to them. Although we are speaking here of societies which obtain Governmental advances, we believe it is generally good policy for *any* society to refrain from paying dividends on stock until it has built an adequate net worth.

It is also important that all earnings be retained in the primary societies, because seasonal fluctuations in agricultural production in India require that societies build reserve strength as soon as possible as a protection against adversity. Such a policy would benefit the societies in other ways also. They would have more of their own funds to invest in loans, their interest cost would be reduced, Government advances could be retired more rapidly and the goal of a cultivator-owned society could be realized more rapidly.

We believe that *there should be no specific date established when the Government's advances would be repaid.* They should be retained by the society until the society has adequate resources of its own to serve its members and potential members. By agreement, repayment could be based upon the relationship of the society's net worth to loans made or outstanding, or upon some other measure of net worth to risk assets. Government advances would be retained only as long as and to the extent they were needed to maintain the ratio specified in the agreement.

It may be that custom will demand that the central and apex banks pay modest stock dividends in order to maintain prestige in the financial community. But since such dividends would be going to the societies and banks of the system rather than to individual or corporate investors,* and since a strong reserve position gives added protection to depositors and purchasers of any securities which the banks might sell, we believe such a programme, together with a proper educational campaign, should actually enhance the prestige of the system.

Most State Governments now hold an investment in the capital stock of State cooperative banks, but several have not yet made such investments in central banks. Investments in these banks and in the land mortgage banks should be without expectation of dividends, without a specified due date and used only to supplement the capital investment of the societies, and banks.

Until the primary societies are able to attract substantial deposits and build net worth they will need to depend largely upon their central bank for loanable funds. Assuming that there will continue to be a capital investment required in some appropriate proportion of these

* It is recognized that some of the older banks have individual share holders, but it is our understanding that individual investments are to be retired and all stock will ultimately be held by the banks and societies of the cooperative system.

loans, the primary societies will be required to use a substantial part of their capital to meet such investment in the central banks. A large share of the Government's advances to the primary societies will, therefore, contribute to the capital of the central bank and through the central banks to the apex banks, thus reducing the Government investment needed in these banks.

It is noted that some primary societies and some banks continue to impose stock requirements upon members when they apply for new loans, despite the fact that they already own enough stock to cover the amount of their borrowing as based upon normal stock requirement standards (8 or 10 rupees per 100 rupees of loan). There is need to build capital in the rural sector and this is one way to do it. But there is danger that such requirements will drive cultivators to the money lenders because they will consider the required capital investment as an additional cost of the loan.

It appears that savings in the rural sector could more appropriately and successfully be stimulated by first developing the cultivators' confidence in the society and its service, and second by offering reasonable rates of interest on deposits. Confidence will develop if the societies provide an adequate and timely credit service and build net worth. When confidence is established, a properly conceived and executed educational programme should be able to attract considerable deposits, especially during the marketing season.

Relation of Primary Societies to Central and Apex Banks

There must be a direct and close working relationship between the Central Banks and the primary societies. All business relationships between them must be handled directly if prompt and efficient service is given to the cultivators. To route loan applications of the society or other business matters through either an employee of the registrar or a supervising union will slow down service and tend to keep the Central Banks in isolation.

Unless the Central Banks have direct contact with the societies they cannot know of the problems of the societies, their ambitions or their successes. They will not be able to maintain contact with agricultural developments so readily. Isolation breeds suspicion and a disinterested attitude. *If Central Banks become or continue to be rural-minded, they must have a responsibility for the successful operation of the primary societies.* It is for these reasons that we have recommended that the officials of Central and also the Apex Banks have some training in agriculture and why we have recommended that the directors of Central Banks be elected by the primary societies and other cooperatives, and as soon as possible.

The future success of the cooperative credit system is largely dependent upon the Central and Apex Banks because they hold the "purse strings." Likewise the future of the Central and Apex Banks is dependent upon the successful operation of the primary societies and other cooperatives in their respective territories. If this is not so, it should be made so by requiring these banks to confine at least all their new business to rural credit. No amount of effort can make the primary societies successful unless they have the sincere, capable, and informed assistance from the Central and Apex Banks.

Credit Worthiness

There are many standards which can be used by a lender to determine who is entitled to credit and who is not. The standard used depends upon the primary objective of the lender.

If the primary objective is safety with little concern for either profit or for service to the borrower, the lender will probably determine credit worthiness upon the basis of pledged assets and he will always maintain a substantial margin between the value of assets pledged and the amount loaned.

If he is interested in maximizing profit from the credit business, he will lend an amount nearer the margin of the value of pledged assets and will also consider the borrower's repayment capacity. If the factor of repayment capacity is strong enough, he might even lend beyond the value of pledged assets.

But if the lender's objective is to provide maximum economic assistance to the borrower by the extension of credit, he will concern himself with the purpose for which the loan is being sought and the likely effect of the loan upon the borrower's well-being as well as his repayment capacity and the value of his pledgable assets. Agricultural credit societies must approach credit with this objective before them, if they are to perform the function for which they were created. It is our observation, however, that many of the societies and cooperative banks are still approaching credit with maximum *safety* as the major objective.

Because of the pressure of population on food supply in India the consumption of food is relatively elastic. Therefore, we do not believe that the extension of credit for increasing food production will create any significant inflationary pressure. There need be no hesitancy, therefore, to provide the credit necessary to get maximum production.

The cultivator's economic welfare is closely linked with his ability to maximize production by tested economic practices. Also the future welfare of India is closely linked with the ability of its cultivators to maximize the production of agricultural products.

Credit is the first requirement of many cultivators, if they are able to purchase the necessary fertilizer, seeds, equipment, etc. to put improved practices into operation and to make the necessary capital investment to conserve moisture properly, utilize irrigation water or drain their land to get maximum production. *An immediate change in philosophy regarding credit worthiness could make an important contribution toward increasing agricultural production in INDIA.*

In brief, a cultivator is considered to be credit worthy and entitled to credit, if he is honest and can repay his loan from production. If such a loan is for a proved production practice, it is most likely to enhance his economic welfare. Such a cultivator might not have, at the time he applies for a loan, sufficient pledgable assets to cover the amount requested plus a margin of safety. But if he has, after the conclusion of the loan, physical assets under his control with which he can produce enough crops (and hence enough income) to retire the loan as scheduled (short, medium or long term), he should be considered to be credit worthy and entitled to credit. Projection of income must be made upon the basis of normal production with adjustment for

improved practices, and probable prices, with some margin for error in making such calculations.

It should not be inferred from this discussion that there is any belief by this Team that credit can substitute for income for any substantial period of time. Credit must be repaid and the source of repayment must be income unless the business is liquidated. *Nothing would cause greater havoc to a credit system than to intermingle credit with subsidy or relief payments to cultivators.*

This discussion does not deal with the question of whether security should or should not be taken on loans. That is for separate consideration. If loans are to benefit the cultivators, the cultivators must have income from which repayment can be made even though adequate security is offered. The Team does not know enough of the custom, laws and other aspects of this question in India to make specific recommendations. We do want to point out, however, that it is in this area of operations that great delays have been reported, especially in connection with real estate loans.

It may be that the laws should be revised when land reform legislation is enacted, in order to simplify the lending procedure when land is taken as security. Obtaining co-signers is a relatively simple procedure and should not cause major delay. Whether co-signers are obtained or assets pledged in support of loans will depend upon the experience of the society. With a proper educational programme explaining, to the members of societies, the advantages that accrue to them as a result of prompt repayment of loans, there should be less need for rigid security requirements. This, however, is recognized as a long-time objective.

Credit and Agricultural Technicians

If credit for production purposes is extended upon the basis of repayment capacity, there needs to be a functioning inter-relationship between the agricultural technicians of the departments of agriculture and the officials of both the primary credit societies and the cooperative banks in order to maximize repayment capacity and enhance recovery probabilities.

We find very little communication between the cooperative bank officials and technicians of the departments of agriculture or the staff in charge of community development. The banks have evidently not been brought into contact with community development activities.

In Bombay State we found one notable exception to the lack of coordination between the bank and agricultural technicians. There the Ministries of Agriculture, Cooperation, and Community Development joined with cooperative banks to promote the Japanese method of paddy production in selected areas on a Pilot basis. This project, usually referred to as the "Paddy Pilot Project," has demonstrated one method of coordinating efforts to achieve a common objective—in this case, to increase the yield of paddy.

We are of the firm opinion that only by a coordinated combined effort of the various agencies of Government can a rapid and significant increase in food production be obtained in India. We, therefore, believe that projects of the nature of the Paddy Project in Bombay, with

some strengthening of the marketing phase, should be inaugurated in other States, in areas where the potential for increased food production is greatest.

Timely Credit Service

It has been reported on numerous occasions that delays in approving loan applications were an important factor in stifling the effectiveness of credit societies. Periods up to five months have been reported from the date of the cultivator's application for short-term credit to the disbursement of his loan. In some cases, disbursement was made after the crop was planted, thereby thwarting the original purpose of the loan. In many cases, the cultivator would have been better off had the delayed loan not been disbursed at all, since arriving too late for production purposes, it was then usually spent for non-productive purposes. Thus it contributed to the total debt load of the cultivator rather than to helping him build financial strength.

It is essential, therefore, that operating procedures of credit societies and cooperative banks be simplified so that cultivators can obtain funds from their societies in a reasonable period of time. Requests of new applicants for short-term production credit should not require over a fortnight for a decision and a cultivator with a good record of performance with the society should be able to receive approval of a normal credit request within a few days. For small amounts he should be able to obtain the funds "over the counter." Only by this kind of service can the society meet all the production credit requirements of its members. This is, therefore, the only way the societies can compete effectively with the money lenders and become dominant in the production credit field.

The type of service described above requires that societies be directed and managed by competent, trustworthy people, that they be delegated responsibility to act; and that they be held accountable for their actions. The societies must have adequate resources to provide a revolving fund so that disbursements of relatively small amounts can be made to meet the emergency needs of their members. Ultimately, the societies should have sufficient resources to be able to disburse practically all of the credit needs of their members prior to submission of their loans to the Central Banks.

Similarly, to provide speedy credit service to the primary societies, the officials of the Central and Apex Banks must be given authority to run their banks. Their judgments should usually be final. Only in cases involving an officer or director should operating matters be submitted to the registrar for prior approval.

It has been noted that in some States a departmental officer is involved in each society's loan application to its Central Bank and by the Central Bank's application to the Apex Bank. In some cases, five approvals are required before a production loan can be granted. Approvals normally require from one to three months for short-term production loans. Such a delay, especially in connection with short-term production loans, makes it impossible for a society to render a beneficial credit service.

Time required to approve intermediate term applications would normally be longer than for short-term applications. Such credit is

usually for a capital investment and often justifiably involves a real estate mortgage. Although the time element must be kept reasonable, a slight delay in receiving approval of an intermediate term loan is usually not as damaging as with seasonal operating credit. This is likewise true with regard to long-term real estate loans made by the land mortgage banks—but even here it seems that an inordinate length of time is required to approve an application and some improvement can surely be made.

There is no India-wide system for bonding employees as a protection against loss because of bad faith, defalcations, unfaithful performance of duty, etc. It appears that this might be an activity in which the States could engage on a self-supporting basis, by the collection of premiums from organizations wishing the protection of bonded employees. With this added protection there should be less need for double checking for the safety of the banks and societies.

Consumer Credit

The Team is primarily concerned with India's food production problem and credit for agricultural production purposes. We are forced, however, to recognize the problem associated with consumer credit, because the borrowing for consumer purposes constitutes a substantially greater portion of the cultivators' borrowing than does borrowing for production. It has been estimated by the Reserve Bank that, on the average, Indian cultivators borrow only about 10 per cent of their production expenditures whereas they borrow 50 per cent of their consumption expenditures and 35 per cent of the amounts put into capital items, such as bullocks, equipment, etc.

Debt caused by borrowing for consumption purposes often places the cultivator in a position where he is not a good credit risk for production credit. He may, in fact, feel that he should not request credit for production purposes.

For these reasons, it appears that the credit societies should enter the consumer credit field as soon as possible and an intensive educational programme should be conducted (probably in connection with the educational work on cooperatives), to teach the cultivators the difference between production and consumption credit, and the advantages of borrowing for production rather than consumption purposes.

If such an educational programme is properly conducted there would be an opportunity to explain the great financial burden imposed upon many families by the dowry system. Dowries have been reported frequently as responsible for the heavy debt burdens of cultivators' families. If this burden could be removed, the problem of financing cultivators would be greatly simplified.

Consumer credit, coupled with a programme to make a greater variety of consumer goods available to cultivators might be a stimulant to production and could induce cultivators to sell more of their produce. *To the extent that an increased marketable surplus was induced, credit extended for consumer goods would not be inflationary.* More information is needed before a final judgment can be made on how much encouragement should be given to promoting consumer credit in rural areas. A study of the effect of consumer credit extended by primary

societies should be of value in determining policy and developing an appropriate educational programme.

There is no question, however, that primary societies are going to have to extend some consumer credit if they are to maintain the interest and loyalty of their members.

7. SPECIAL PROBLEMS OF LAND MORTGAGE BANKS

There are many cultivators throughout India who, if they are to get maximum production, must make medium and long-term investments in their land for such purposes as irrigation development, contour bunding for water conservation and other soil conserving practices. *The land mortgage banks have an excellent opportunity to make a real contribution and to develop business and prestige if they can develop a sound scheme of financing which will assist the cultivators to properly develop their land.*

Such a scheme must be based upon the repayment capacity and value of the developed land rather than the value of the land prior to development. To ensure reasonable accuracy, this approach to estimating repayment capacity and value would require that a study be made by competent technicians (both from the natural sciences and economics) to determine the results that would be achieved by the proposed development. Here close liaison with technicians of the departments of agriculture and irrigation and drainage would be required. Pilot projects would probably be necessary to develop reliable information.

If the land mortgage banks provide the long-term credit which is necessary for India to meet its food production goals, they must obtain substantially larger amounts of loanable funds. This could be done by broadening the market for their debentures. It appears to us that the present policies of the banks with respect to their debentures need to be changed if a wider market is developd.

Although we believe that the term of the debentures sold by the banks should generally be related to the term of loans made, we do not believe that this policy need be so rigid as to prevent the issuing of some shorter-term debentures (perhaps 5 years should be as short a term as the banks should issue at this time), when money is more available in that sector of the market.

It is recognized that shorter-term debentures would create problems in connection with the building of sinking funds for their retirement but we do not believe that the sinking funds, of the nature now maintained by the banks, are necessary for the safe and proper conduct of their business. We believe that the financing of the bank operations should be looked upon as a continuing process and need not be segmented by separate debenture issues. It may be to the banks' advantage to retire outstanding debentures by the issuance of new debentures rather than by liquidation from sinking funds.

This is not a new practice, but is being followed by the land banks in the United States. The debentures are supported by the total resources of the individual banks and are guaranteed by the Government so there need be no concern by the purchasers as to their safety. Such a practice could be limited to the older and stronger banks in the beginning.

If shorter term debentures were issued and the volume of the banks increase, there would probably be need for more frequent sales. With more frequent sales and terms of issue more acceptable to the market, there will be more trading in these securities, the resale of the securities would be expedited, and a greater demand should develop. To develop this market properly all purchases or sales, even by the banks themselves, should be channelled through the central money market.

More frequent sales and a more receptive market for debentures would provide additional funds to the banks and reduce the demands on the States, the State Bank of India, and the Reserve Bank for interim financing.

8. MARKETING AND SUPPLY

The Role of the Primary Society

The Rural Credit Survey* recommended that "agricultural credit societies may also supply members' requirements for crop production and also basic, but standardized, consumer goods on the basis of indents or established demand." Further** the Plan provides for the establishment of 1800 marketing societies. "They are set up at important marketing centres, and agricultural credit societies as well as agriculturalists belonging to villages from which there is a natural flow of harvested crops to those centres, are enrolled as their members. When production loans are given by credit societies, the borrower signs an agreement to deliver the crops raised with the loan at the marketing society to which the credit society is affiliated, and that the marketing society may recover his productions loan for the credit society either out of the sale proceeds of the crops or out of any loan it may advance on the produce left in its godown."

It will be seen from these quotations that it is intended that the primary society will extend credit, distributes supplies, and assist members to market their crops. Obviously, each primary society should have a godown near by in order to carry out these functions. The primary society does not actually market the crops, nor does it have responsibility for arranging the purchase of supplies. But it is a stockholder in, and has representation on, the board of directors of (its affiliated) marketing cooperative, which has these responsibilities. The primary society functions more in the nature of an agent for the marketing cooperative. This coordination makes it possible for the primary society to extend a part of its credit in kind and also to be in a position to effect recoveries better.

"Marketing" cooperatives are intended to perform both the supply and marketing functions in India.

The Supply Functions

We have been impressed with the ever-recurring problem of how to get the needed supplies to the cultivator at the *time* they were

* "Summary," All-India Rural Credit Survey Report of the Committee of Direction. Vol. II.

** The Integrated Scheme of Rural Credit, Reserve Bank of India.

required, and in the *variety* and the *quality* recommended by the block staff and within a bullock-cart haul distance of the cultivator.

We find that much of the time of the staff at all levels—Centre, State, district and block—is taken up with the organizational problem of getting the supplies out to the cultivators. In various sections of the report we have made reference *to the necessity of shifting the responsibility for the organization of the agricultural supply lines from the block agricultural officer and the VLW to the cooperative departments of the States and their staff in the field.*

While there will always be a place for the enterprising honest private entrepreneur who wants to make a business of stocking and selling agricultural supplies, total reliance cannot be placed on private enterprise to fill the gap of immediately supplying the cultivator with the tools, fertilizers, seeds, etc., he will require at once for an intensive food production campaign.

If primary societies are to be effective in meeting the village cultivator's requirements for agricultural supplies, they must have organized decentralized supply centres where they can place orders with assurance of rapid deliveries.

In general, one cannot expect the primary societies to have the capital resources to carry large stocks of supplies. The affiliation, therefore, of the primary societies with marketing cooperatives having storage facilities is both wise and necessary. The "integrated scheme," which is generally accepted in India, provides that the board of directors of these marketing cooperatives will be made up of representatives of the affiliated primary societies.

The required credit for the individual cultivators to purchase their supplies will be provided by the primary societies. If the marketing cooperatives at the mandi centre is effectively to meet the needs of its affiliated primary societies there must be a very close relation between the two. At least six months in advance of the primary society's needs for specific supplies, these projected needs must be communicated to the marketing cooperative so it in turn can stock the supplies.

Since many of the required agricultural supplies will not be manufactured in the immediate vicinity, the marketing cooperative should set up immediately its contacts with sources of supply of seeds, fertilizers, etc., needed from distant suppliers. It should also take the initiative in establishing manufacture of supplies, which can be made in the villages, such as agricultural implements, and certain insecticides. These cooperatives should also assume the leadership in developing processing facilities for the foods and fruits which can be grown in the area. Should the production of poultry develop in these areas, they could also establish hatcheries to supply improved chicks to the primary societies.

With the affiliation of a group of primary societies with a marketing cooperative having both supply and marketing functions and providing adequate storage and other related services as outlined above, it will be possible for the marketing cooperative to have a sufficient volume of business to employ competent management, establish adequate accounting procedures and engage in some educational activities

with the affiliated societies. (Many primary societies could not alone afford to pay for or provide these facilities.)

Distribution of Fertilizers: Of the projected increase in food-grain production under the Second Plan, about 25 per cent is expected from fertilizers and manures and 10 per cent from improved seeds.

Production, imports and distribution of all chemical fertilizers is controlled by the Central Government with assistance from the State Governments. Since 1943, a central Nitrogen Pool in the Ministry of Agriculture has made allocations to specific classes of users. About 20 per cent has gone to tea, coffee and rubber plantations, with the remaining 80 per cent allotted to the various State Governments for distribution to their cultivators and to manufacturers of mixed fertilizers. State allotments are further allocated to districts by the State agricultural officer in consultation with the district agricultural officers.

All States are now using agricultural cooperatives to distribute chemical fertilizer. However, in a few States, fertilizer manufacturers and other private businessmen are still handling the bulk of the distribution. Much of the growth of chemical fertilizer production has occurred under the spur of Government programmes. Similarly, major control has been exercised over market distribution by making allotments for specific crops and regions together with loans and education to make the cultivators fertilizer conscious.

We believe that the cooperatives should be brought into the distribution structure as principal marketing agencies as rapidly as is permitted by their organization and the availability of suitable facilities and personnel. *Marketing fertilizer through cooperatives should help strengthen the cooperative movement by providing additional responsibilities, increasing contacts with cultivators and increasing volume of business.*

The Marketing Functions

Most of the cultivators are small-scale producers, utilizing a substantial portion of their food-grains for personal consumption and marketing only a small quantity. Where the individual lacks the knowledge for proper performance of the marketing function, the group may organize to have these functions performed jointly. The cultivators may directly, or through their primary societies, organize their marketing associations, pool their produce and hire an agent to make the decisions on when to sell, where to sell, how much to sell, and an acceptable price.

Cooperative marketing is needed to strengthen the bargaining position of the cultivator at the first stage of marketing—from the farm to the wholesale market. It can add to the withholding power of the cultivator by giving him a loan or advance payment to meet his immediate needs. The cooperative can keep his produce in storage along with that of other members until it can be sold at a fair price. The very fact that his produce is held from the market acts as a stabilizing and price-strengthening factor because concerted action is being taken. If the quantities involved are substantial in amount, the cooperative acquires a position of strength in dealing with traders

and, therefore, it can sell to advantage. Also the processes of storage, grading, cleaning and quality control become more feasible and economical for large quantities.

Cooperative marketing has been recommended as a result of several analyses of Indian agriculture—the Royal Commission on Agriculture in India in 1928, the Marketing Sub-committee of the Policy Committee on Agriculture, Forestry and Fisheries in its Report in 1946 and the Rural Credit Survey Committee Report.

These reports stress the importance of cooperative marketing as a means of advancing funds to the farmer at harvest time to help meet his consumption needs, pay his pressing debts but still not force him to resort to the final sale of his produce in an unfavourable market. The combination of cooperative credit and cooperative marketing should free the producer from his reliance on the private money lender and trader as a source of credit and as a market for his produce and provide the services of credit and selling at lower cost and a higher net return to him.

Although cooperative marketing is accepted as a desirable goal, it has not attained wide adoption in India. The volume of agricultural produce handled by the cooperative marketing system forms a very small proportion of the total value of the marketable agricultural production. Food-grains provide only a minor part of this cooperative activity. Ultimately, to reduce inter-market price variations and to serve as a major part of a coordinated price stabilization scheme, it will be necessary to establish a broad base of marketing societies, with these societies federated into units for the performance of such functions as processing, sale to State or Central procurement agencies, or other functions which require large volume, capital and quality control.

A suggested structure for a nation-wide organization of marketing cooperatives was given in the Rural Credit Survey Report. This report suggested that the Ministry of Food and Agriculture operate in this field in conjunction with the State Governments. At the Ministry level, a National Cooperative Development and Warehousing Board was suggested to serve as an all-India planning, financing and co-ordinating body. At the State level, State cooperative marketing societies would be established and programmes would be developed for the state-wide organization and development of cooperatives at mandi markets or at taluk centres.

Action in Parliament to carry out these recommendations was formulated in the Agricultural Produce (Development and Warehousing) Corporation Act, 1956. Programmes are under way in individual States and progress has been made. It is still true in 1959, however, that only a small portion of the food-grains are marketed cooperatively.

There are several reasons for the slow growth of cooperative marketing. The small quantities sold by the cultivators must be pooled for any efficient method of sale and this is not always acceptable to them. Cooperative marketing involves more formalities than does sale to a money lender or trader. It may involve waiting for final settlement until some time after the produce is delivered. The spirit of cooperation is frequently lacking and individuals do not prove loyal. Competition from existing private agencies is strong and the people involved are influential. Many devices are available to destroy or

weaken the cooperative and each failure has a retarding influence for many years.

In addition to loans and subsidies by the States, made possible by the establishment of the National Cooperative Development Board, *it is suggested that strength be given to the cooperatives by using them as an agency for price stabilization.* Quite commonly food-grain shortages exist in urban areas and in those rural regions which are not major food-grain producers, while elsewhere surplus grains are available and prices may be quite low. State purchase operations through marketing cooperatives in surplus areas would have the effect of strengthening prices there. Movement of these supplies through cooperative societies in deficit areas would alleviate inflationary pressures and utilize the facilities of these cooperatives.

Purchases would be concentrated during the post-harvest months when prices in the producing areas drop to their lowest levels. This would have an immediate price stabilizing effect at the time that it is needed most. Thereby price variations over time would be held to a minimum, as well as price disparities between markets. By having these purchases made through the cooperatives, the Government is relieved of the necessity of buying through private traders. The individual cultivator reaps the benefit of the increased price and the movement of grains is facilitated into the areas where it is needed most.

Processing of Crops for Market: Processing of agricultural produce is a major complementary activity for some cooperative societies. Because of the heavy investment required, marketing societies frequently join forces to establish a processing plant. The major development has occurred, not in food-grains, but in such activities as cotton ginning, sugar factories, coffee curing and the like. Paddy hulling is the major need among the food-grains although the milling of other food-grains may become increasingly important.

The target for cooperative processing plants under the Second Plan is 118 other plants in addition to the sugar factories; and cotton gins. In some cases, development of processing plants for paddy hulling is slowed by the active promotion of hand-pounding by Government or State officials. Hand-pounding usually gives a higher recovery of rice than machine-rubbing since less bran is removed. However, hand pounding also results in more broken kernels which detract seriously from the ultimate value of the rice in the market.

There is prejudice against machine hulling in some areas. The Report on the Marketing of Rice in India estimated that about 35 per cent of total rice production was machine milled. Present estimates do not indicate much change since that time and no new licenses for rice mills are being issued at present.

Since costs of hand pounding are reported to exceed machine milling costs, we believe that the cooperatives in areas having substantial marketable surpluses of rice should be encouraged to establish, either individually or jointly with other cooperatives, cooperative paddy hullers or rice mills. This can facilitate the improving of rice quality and result in higher prices for the milled product.

At the present time the rice milling industry is mostly in the private sector, as is most of the wholesale trade in rice. It seems possible to require that all new paddy hulling units be set up on cooperative lines and to encourage cooperatives to purchase existing units

where suitable terms can be arranged. The goals of obtaining highest returns from sale of the cultivators' food-grains and stabilizing food-grain prices can both be achieved to best advantage through the combination of cooperative marketing and processing. In addition, it facilitates the collection of loans from the cultivator.

Storage

If the producer of food-grains is to achieve a strong position from which to bargain with the trader and maintain an adequate stock of production supplies, proper facilities must be available for storage. Unfortunately, heat, and at some times and some places, humidity, are generally favourable to insect growth in stored seed and grain. Rodents provide an additional hazard under average conditions. Grain must be moved into consumption rapidly after unfavourable conditions develop. We have found no estimates on losses through insects, rodents, moisture and moulds but it is evident that they are considerable. It is not likely that the average cultivator is capable of maintaining proper quality over protracted periods with his personally owned facilities.

The general desirability of storage is well recognized in India. The Second Five Year Plan authorized targets for the development of organized storage and warehousing as follows:

	Number
Warehouses of Central and State Corporations	350
Godowns of marketing societies	1500
Godowns of large-sized societies	4000

Under the Agricultural Produce (Development and Warehousing) Corporation Act 1956, provisions are made for a Board to plan and promote programmes for the production, processing, marketing, storage, warehousing, export and import of agricultural produce through a cooperative society or a warehousing corporation. The Central Warehousing Corporation may acquire and build godowns and warehouses at suitable places in India. The State Warehousing Corporation may acquire and build godowns and warehouses at such places within the State as it may determine, in consultation with the Central Warehousing Corporation. The proper legislative framework has thus been supplied for the necessary storage construction.

Before the above legislation was enacted, the Central Government and State Governments had acquired warehouses of large capacity in connection with the food programme of the Ministry of Food and Agriculture. This existing storage can be supplemented by large-scale warehouses provided by the Central Warehousing Corporation and smaller warehouses provided by the State Warehousing Corporations.

Most of the planned storage is not yet complete, particularly at the village level. Numerous questions must be answered regarding location, construction and management. The possibilities of introducing bulk handling of grain as a substitute for bag handling is being considered in some areas. Development of practical grain cleaners, moisture testers, screw conveyors, bag conveyors and grain dryers are all receiving considerable attention. Meanwhile, an active programme of storage construction is going forward.

Cooperative societies receive assistance for the construction of godowns with 75 per cent of the help in the form of loans and 25 per cent as a direct subsidy. Beyond the villages, larger godowns will be constructed at important market centres. Addition of this storage capacity should improve the bargaining position of the cultivators in both the marketing and supply functions, increase the potential efficiency of the cooperative society, and decrease the waste and losses associated with present storage and handling methods.

The use by cooperatives of safe, well-built storage enables them to obtain bank loans on market grain for use in preliminary payments to producers. This permits the produce to be held from the market during the period of lowest prices and to be sold in an orderly fashion. The grain is held in the area for possible use during the off season, the godown performs its storage function, and the cultivator reaps the benefit of sale at the proper time

Godowns at the village level are badly needed. Most food-grains are stored in home-made structures of straw, bamboo splits or in mud or wooden bins. In such structures, there is much greater danger from weevil or rodent infestation or from dampness than in masonry godowns with wooden, stone or cement flooring. It appears to us that if the primary societies are properly capitalized and building materials are made available, the societies could construct godowns for village use where they do not now exist.

We believe it is especially important that the primary societies have godowns in areas producing a marketable surplus of food-grains. Only storage owned by the cultivator or by his cooperative will provide him with a stable market at the time of harvest. Thereby, storage at the village level becomes a definite part of a price stabilization programme.

The use of the village godown by members of the primary society for storage of their seeds, fertilizer, food-grains for family consumption, etc., is desirable. Such storage would eliminate the cost and inconvenience of home storage and lessen annual storage losses.

The possibiltiy of using funds from grain imports for godown construction should be investigated fully. It is possible, for example, that funds available from grain imports under PL 480 and other special programmes might be used to construct needed godowns in village areas. This could be especially desirable as domestic supplies of steel and cement become more available.

9. LEGISLATION

It is evident that there is need for legislation in the various States to modernize their laws relating to cooperatives. A review of these laws is now in progress. We have not had time to study present or proposed laws but we would state as a general policy that the legislation finally enacted should permit the States to assist primary cooperatives financially and otherwise during their developmental period. The States should have continuing authority to protect the interests of members and the public interest through audit and inspection. But the responsibility for day-to-day operations must rest with the board of directors and managers of the cooperatives. Only by

having local responsibility for operation can the cooperatives be responsive to local needs and develop local leadership and initiative.

There is need also for the States to clarify and perhaps modify their laws relating to property rights in land following land reform legislation, in order that the land mortgage banks might safely extend long-term credit upon the security of land. Specific legislative measures to accomplish these objectives could be properly drawn only after a careful study of the present laws in each State by an appropriate committee or agent representing the cooperative banks and societies.

It appears also that there needs to be review of present State laws as they apply to crop production loans. Since the policy of making production loans on the basis of expected crop yields is relatively new, it is likely that there need to be some changes in law to give adequate protection to the lender.

CHAPTER II — ECONOMIC INTELLIGENCE AND OUTLOOK

If food production targets are to be established on a firm basis, and realistic plans made for their achievement, adequate information must be available on demands in different markets, and on production potentials in different producing areas. *Available data on production, market supply, demand and price of food grains are inadequate.* Yet these data must be used as a basis for decision-making by Government administrators, cooperatives and cultivators, as well as by other agencies and individuals concerned with food problems.

The data deficiencies seem especially acute at the village level. It is very difficult to obtain accurate information on the resources used in production and the quantities of each commodity produced by cultivators of an individual village, the amounts entering the channels of trade, the prices paid at the village level, the quality of produce, the losses between time of harvest and consumption, and seasonal changes in prices. Yet the success or failure of food programmes will be decided at the village level.

Some work is being done in the States and at the Centre in collecting and publishing market information for agricultural commodities. Data regarding prices, market arrivals, storage stocks and dispatches are being collected from a number of markets. Marketable surpluses for individual crops are estimated currently from data obtained from a sample of markets.

But a more comprehensive plan is required for obtaining and analyzing data. More full-time reporters are needed in important markets to obtain price and related data. In addition, more reporting should be initiated in villages. Responsible individuals are available at the village level, including both Government employees and private citizens. It should be possible to designate one or more persons in each village to supply data on current weather and crops, intentions to plant, crop conditions, estimated yields and trends in acreages and yields. As experience is gained, showing the extent of error or bias, the data can be adjusted to indicate actual conditions on a continuing basis.

Information should be obtained concerning the land, labour, power, fertilizer and other resources used in production. It would also be helpful to collect data on credit extended from different sources, and the repayment experience. Similarly, as the food grains move into the village markets, data should be obtained from village sources on quantity, quality and price of farm marketings, quantities in storage, losses in storage and movements by type of transportation. By coordinating these data with those obtained from the major markets, it would be possible to maintain accurate estimates of available supplies.

Stocks of food grains are held partly by the Central and State Governments and partly by private traders. Information should continue to be summarized on Government procurement in different areas, distribution by areas, location of Government stocks and planned rates of issue. Also, since both imports and exports of food grains are under close Government control, it should be possible to maintain excellent estimates on supplies and movements during any period of time.

Demand estimates are quite complicated in that they involve correlation of data from several sources. Population data are available

from the Registrar-General of Population Census and estimates are now available for the periods between the censuses. Analyses are made on a continuing basis of birth rates, death rates, in and out migration, extent of urbanization, and distribution of population by age groups. These data are especially important in providing a basis for estimating per capita needs and expenditure. Data on population growth are especially important to provide an estimate of future food requirements.

Additional data on demand which are required include national income and expenditure, money supply, velocity of circulation, deficit financing, bank credit and public and private savings and investment. These data are collected primarily by the Ministries of Finance, the Reserve Bank, the Central Statistical Organization, and the Ministry of Commerce and Industry. The combined data provide a basis for forecasting changes in per capita consumption of various items including food grains. Closely associated data are required to indicate actual consumer behaviour in urban and rural areas, price and income elasticities of consumption by population groups, and the degree of substitutability for food grains, individually and collectively. The major problem, then, is to properly organize the collection and compilation of information from different sources.

We suggest the development of an Agricultural Economic Intelligence Organization at the Centre with the responsibility for making short-term and long-term forecasts and summaries for food grains and other agricultural commodities. This involves the collection and organization of the necessary data, and rapid processing of the data to permit timely analysis for use in decision and reporting. An excellent beginning has been made within the Ministry of Food and Agriculture. The major need is to broaden the data-collecting process, speed up the processing and improve the dissemination of the results. The information provided by an economic intelligence organization is not only essential for administrators; it will provide a basis for obtaining an understanding of the food situation by cultivators and the general public. As cultivators learn the need for expanded food production, and the production potentials of their own village, they can participate intelligently in establishing production targets that represent realistic achievements village by village and area by area.

It is believed that by assessing the forces that are likely to operate in the future and by working out the quantitative relationships involved, the improvements in decision-making will repay all the costs of the enlarged Agricultural Economic Intelligence Organization.

Market Information for Cultivators

If growers are to obtain fair prices for their food grains, speedy dissemination of reliable market information is an absolute necessity. Cultivators obtain their price information by word of mouth and are constantly guided by inaccurate or untimely data. *We suggest that in view of the need for market information to cultivators, a programme be initiated to install and maintain a radio in every village in India for dissemination of market reviews by the All-India Radio.* It is suggested that an immediate test be made in one district in each State. The daily press should also be encouraged to carry commodity prices, market reports and similar information.

The absence of uniform quality standards prevents strict comparisons of value between markets, and the astonishing diversity of weights and measures complicates matters further.

The first essential for market information for cultivators, or for national intelligence on market supplies and demands, is the general adoption and use of a standardized system of grades and standards and weights and measures. This problem is discussed in the following chapter.

CHAPTER III—SOME PROBLEMS OF FOODGRAIN MARKETING

By far the largest portion—over 75 per cent—of India's foodgrain production is never marketed. Most of the cultivators have small acreages, and since their yields are low, their total production per farm is not great. Foodgrains comprise a major portion of their diets and many cultivators consume all that they produce and may even buy additional supplies. Also, in the villages, labour is commonly paid with foodgrains for both agricultural work and other services. Additional supplies are retained for seed.

The accompanying table summarizes the estimate of marketable surplus for foodgrains for several years. This includes both the quantity sold in the villages to meet local needs, and the quantity brought to assembling markets to meet the needs of urban consumers. The total marketable surplus represents less than 25 per cent of total foodgrain production in an average year.

It is this marketable surplus which becomes the commercial supply. Storage, transportation, grading and credit are required to make these supplies available to the ultimate consumer. A variety of marketing institutions have developed to perform these functions. Ultimately, it is anticipated that the cooperative marketing structure will play a major role in obtaining a fair price for the producer and reducing to a minimum the spread between this price and that paid by the consumer.

Our limited observations indicate that the present marketing system in India fails to perform in an efficient manner the individual marketing functions. Yet substantial progress is being made in improving transportation, storage, processing and other functions. In the chapter on cooperatives, the Team has discussed some of the problems of storage and processing. It is not possible to discuss here all of the many other problems involved in the marketing of foodgrains. We limit our comments here to two aspects which we believe are most needed for an effective marketing system.

Grades and Standards

Foodgrains show a wide range in quality. Any difference should be reflected in market prices, in order to reward cultivators who have produced superior grains and to discount grains that are less desirable. Prices varying according to quality could serve as a guide to future production. Unfortunately, most transactions in the assembling markets do not take place on the basis of any quality standards. All produce is sold at the same average price except to the extent that a better price is achieved through bargaining. Reductions for dirt, mixtures or damaged kernels are usually arbitrary and often unfair. Sale by physical inspection establishes no basis for grouping of lots or further sale by description.

This absence of uniform standards has led to a multitude of local quality designations. These are of little help in consummating contracts between traders and processors separated by long distances. Uniform price reporting is impossible because there are no comparable quality designations by location. A start has been made in developing nation-wide grades and standards in order to facilitate the exchange, storage, and processing of foodgrains.

The Agricultural Produce (Grading and Marking) Act of 1937 provides the basic legislation for the grading of agricultural products. The "Specifications of Indigenous Foodgrains," issued in 1951 by the Directorate of Storage and Inspection of the Ministry of Food and Agriculture, provides the equivalent of standard grades for grain by establishing the relative worth of varying qualities. Grading rules and specifications have been issued covering rice but not other grains.

Some start must be made in the grading of other grains. Pressure for such grades for wheat and most other grains has been less than for rice since almost no grain except rice is exported and the local trade has developed its own practices. Prices vary in terms of locality preferences, types and quality as well as general supply and demand conditions. An ideal set of standards will probably take years of investigation and can represent only a compromise.

Despite these difficulties, we suggest that the Ministry of Food and Agriculture experiment with tentative grades for grains. A number 1 or Premium grade could include the superior or very best commercial delivery; the number 2 could have quality requirements to include the bulk of the produce; the number 3 grade would be basically wholesome but include a larger proportion of admixtures and damaged or broken kernels; and the number 4 grade would be of low quality, suitable only for livestock feed or requiring expensive cleaning for human consumption.

Popularizing and securing general adoption of grading will require a concerted effort on the part of all Government-sponsored institutions involved in marketing. Regulated markets and cooperative marketing societies, for example, should adopt statutory grades for their trade transactions as soon as possible. Similarly, the official reporting agencies should quote prices in terms of official grades wherever possible. It might be advisable to give higher priorities to graded foodgrains in booking railway cars. This would encourage proper cleaning of grains early in the marketing process. Only by a concerted effort can the economies and other benefits of graded produce be realized.

Regulated Markets

A regulated market serves as a means for promoting orderly marketing, adoption of fair trading practices and maintenance of competitive conditions in buying and selling. It strengthens the position of the cultivator and permits him to obtain a fair price for his produce. It promotes orderly and stable conditions and provides a standard by which the cultivator can estimate current market values.

Progress toward regulated markets has been slow except in a few States. Some of the regulated markets have developed weaknesses in their operation. The absence of facilities for grading and standardization has been a problem. Methods of weighing used by individual traders have led to some abuses. Many market committees have failed to protect the interests of the cultivator, succumbing to pressure from the traders on individual points of regulation.

In some States, close working arrangements have been made between cooperative societies and the regulated markets. Actual management of the market by a cooperative organization strengthens

the financial position of the cooperative and provides a strong impetus to its expansion and development. Members of the cooperative are induced also to take advantage of the benefits offered by market regulation. Currently, this cooperation is possible only at a few locations. Either cooperative or regulated markets strengthen the position of the cultivator and contribute to price stabilization. Their expansion should be encouraged.

It is suggested that the development of regulated markets be stressed especially in areas with large marketable surpluses of foodgrains. The cooperative marketing societies may continue to meet with opposition and competition from established traders. But if a representative of the marketing cooperative is a member of the market committee in the regulated market, he can protect the interests of the cooperative. The cooperative will operate to the best advantage if the programme for price stabilization is conducted through the marketing cooperatives and at the regulated markets.

Marketable Surplus of Cereals

(Calculated from production adjusted on 1956-57 final estimate)

Year	Rice (31.5% of Production)	Wheat (35% of Production)	Jowar (23.8% of Production)	Bajra (26.5% of Production)	Maize (24.5% of Production)	Ragi (18.9% of Production)	Barley (26% of Production)	Small Millets (16.14% of Production)	Total Cereals
				(Million Tons)					
1949-50	7.5	2.3	1.6	0.8	0.6	0.3	0.6	0.3	14.0
1950-51	6.6	2.3	1.5	0.7	0.5	0.3	0.6	0.3	12.8
1951-52	6.7	2.2	1.6	0.6	0.6	0.2	0.6	0.3	12.8
1952-53	7.2	2.6	1.7	0.8	0.7	0.2	0.7	0.3	14.2
1953-54	8.9	2.8	1.9	1.1	0.7	0.3	0.7	0.4	16.8
1954-55	7.9	3.1	2.2	0.9	0.7	0.3	0.8	0.4	16.3
1955-56	8.5	3.0	1.6	0.9	0.6	0.3	0.7	0.3	15.9
1956-57	8.9	3.3	1.7	0.8	0.7	0.3	0.7	0.3	16.7
1957-58	7.8	2.7	1.9	0.9	0.8	0.3	0.6	0.3	15.3

CHAPTER IV—RESEARCH IN AGRICULTURE ECONOMICS

Even a hurried look at the agriculture of India spotlights a few striking facts: the economic importance of agriculture to the nation; the dependence of a majority of the population upon agriculture for their livelihood; the low average levels of agricultural production; the inadequate returns to the average cultivator; and the extremely high man-land ratio.

Not so evident are the answers to a series of questions which must be answered if food production is to keep in step with the rapidly increasing population. How can the marketable surplus be increased? What are the elements of a good land tenure policy for India? How can agricultural cooperation be organized to accomplish its task of freeing the cultivator from his economic bonds? What incentives induce cultivators to undertake the improvements necessary for expanded production? What are the comparative costs and returns from the variety of potential programmes of education and assistance in agriculture?

These problems and many others require rational, scientific study by trained specialists. The current difficulties are acute and identifiable, and adequate analyses will suggest causes and possible remedies. The alternatives—of letting matters drift or of taking action without prior study—can only result in further loss of time and scarce resources without appreciable progress.

Research is the foundation of progress. Modern industrial concerns as well as nations find a consistent relationship between expenditures for research and rate of economic growth. In wartime, the most pressing problems receive priorities in personnel and funds, in order to obtain the necessary answers as quickly as possible. The situation in India today is comparable. The problems exist, the answers are needed *now* and yet economic research receives inadequate personnel and funds. This is true despite the acknowledged value of such studies as the Rural Credit Survey. A hasty review of the Indian literature in agricultural economics reveals a comparative lack of detailed studies which can be used for decision making. The bulk of the existing materials are descriptive in nature, with a minimum of analytical results. Such fields as farm management, agricultural marketing and land tenure are relatively unexplored. Attention has been focused on broad problems of policy and development.

The individual cultivator is the key person in any programme to increase food production, but comparatively little is known about him and the basis for his decisions on what he will produce and how. He must be persuaded to change his present pattern of production if food targets are to be achieved. Research can reveal comparative costs and returns from such practices, and combinations of practices such as fertilizer, improved seed, mechanized equipment, controlled grazing, soil and water conservation, marketing cooperatives, and the like.

We believe that an immediate start should be made to initiate research that will arrive at solutions to each of the major economic problems facing agriculture. We find the same needs for research answers in India as in other countries, and a great deal of experience and methodology can be adapted to India. The International Conference of Agricultural Economists held in Mysore in August 1958

demonstrated very clearly that India has competent leaders in agricultural economics. But many more are needed, and funds must be available for productive research on pressing problems.

A programme has gone forward between five Indian educational institutions and The Ford Foundation to train graduate students in social science research methodology. Similar programmes on an expanded scale should be initiated by the Centre.

There is urgent need for one outstanding centre for graduate training in agricultural economics. Emphasis should be placed on training in economics of farming in view of the crisis in food production. Research programmes should be expanded as more trained workers become available. We believe that the resulting improvements in the planning and execution of food programmes will more than pay for all of the costs involved.

Special attention should be devoted to types of farm management research that can provide guidance to the food production programme.

India has very little farm management research under way at the present time. Some descriptive research has been undertaken, and a few of these studies do provide data on inputs and outputs that can be used in farm planning. In fact, some of these data have been used to demonstrate the possibilities of farm planning as a tool in guiding food production programmes.

More recently, the Directorate of Economics and Statistics in the Centre Ministry of Food and Agriculture has undertaken a cooperative study with several States on farm planning. This research should be greatly expanded, and adapted to serve more adequately as a guide to development of food production programmes. Additional financial support will be necessary.

Recognizing the enormous area to be covered and the need for providing information as quickly as possible, we suggest that farm management research be developed along the following lines:

1. Every State Department of Agriculture should establish a section on agricultural economics which would be responsible for development of both farm management research and extension within the State, and for cooperation with the Centre on research of nation-wide importance.

2. In so far as possible, the actual research in farm management should be centred at the agricultural colleges. Those who are teaching agricultural economics would then have an opportunity to study actual farm and village problems, and to use the results in their teaching as well as making them available for programme guidance. A close working relationship should be maintained with the extension farm management specialists stationed at block headquarters.

3. The research should concentrate on case studies of farms that would be representative of sizes and types most important in the area under study. Available census or sample survey data should be used to determine the representative character of the farms selected for study. Care also should be taken to select, for case study, farms with soil and water conditions broadly representative of the area to be covered.

4. An inventory should be made of the resources of case-study farms. The present crops and livestock should be analyzed to determine

the inputs and practices used, and the physical outputs. An estimate would then be made of income, expenses and net returns from the present system of farming.

5. Estimates should be made from all available information of the results that might be obtained from introducing new crops, new practices and better feeding and care of livestock. The income results should be compared with the present system and attempts made to persuade cultivators to adopt the improved system.

6. Similar analyses should be made of the case-study farms in succeeding years. The results of the improvements made would be evaluated in this way. If farmers could be persuaded to keep simple records, the analysis would be facilitated, but on farms of the usual size adequate estimates can be made by the cultivator and checked by the researcher.

7. If year-to-year case farm studies of the type outlined could be made in a large number of areas, the results could be used to indicate the potentialities of programmes for increasing food production and the well-being of cultivators. The returns on the farms where major changes have been made would serve as one indicator of progress. The gaps in other research information would be revealed by such studies and steps could be taken to fill them.

Other types of farm management research should be undertaken as problems come to the forefront, but we believe that case farm studies in areas with broadly similar production opportunities will contribute most directly to food production efforts.

CHAPTER V — GENERAL COMMENTS ON AGRICULTURE RESEARCH AND EDUCATION

The Team has focused its attention primarily on problems of how to increase food production directly. Research and education have been dealt with only as they related to this objective, and many proposals on both have been made in other sections of this report. Here we make a few general observations that have emerged from our studies.

Clearly research must pave the way for the far-reaching changes in Indian agriculture. Clearly, too, if India expects to have food enough for its rapidly growing population, it must have an increasing number of increasingly better trained agricultural scientists, educators, extension workers, and agricultural administrators.

Agricultural Research

To assure that research is making its proper contribution to food production, an inventory of agricultural research should be made to determine what information may be lacking, what research gaps need to be filled, and what new projects should be undertaken.

More effective channels of communication should be established so that research workers are promptly and continuously kept informed in their own and related fields of what is going on and of research findings and results from all over the nation, and other countries as well.

More effective coordination of agricultural research is necessary not only within a particular subject-matter area, but also among the various specialized areas. Research in specified fields (especially where financed by the Centre) should be planned on an integrated basis, so that all projects and activities dealing with allied subject-matter can be effectively related to the problems in the field. More effective coordination within and between the States and between the States and the Centre is also very necessary.

Where research on single practices or individual crops is carried on at separate locations, greater consideration should be given to including the important factors relevant to the research project, such as soil conditions, irrigation, fertilization, plant protection, plant breeding, and others. Where possible, research programmes at particular locations should be broadened so as to reduce the amount of research work carried on in isolation at remote places. We urge this because we are convinced that research prospers most where research workers can associate with colleagues in their own and related fields.

Moreover, *we would urge that India give greater consideration to team approaches in both planning and implementing research.* Most agricultural problems are complex and can often be solved most effectively by the combined efforts of scientists from two or more disciplines. Indeed there are few problems which cannot be solved more effectively by a team approach, in less time and with less expenditure of effort and money.

All research activities, research findings and technical knowledge must be related to the cultivators, who in the final analysis must

apply the results of research to their own farming operations. The bridge between the researchers and the cultivators is the agricultural extension worker.

A substantial number of the problems on which research workers in agriculture spend their time should come from and be identified in the village and by the cultivators. Research activities should in large part be framed by the needs and difficulties of the cultivators. If this is done, research findings can more readily be put into village practice.

For this relationship to be fruitful, extension workers must be trained to recognize problems requiring research, as well as to see their own limitations in specialized fields. They must feel the need to call for specialist assistance. Specialists and researchers must in turn recognize their obligations to assist extension workers and cultivators.

It is especially desirable for research workers at the agricultural colleges to be closely tied into field problems so that their work might similarly make a direct contribution to food production. We endorse the policy of relating the agricultural colleges to specific blocks in their vicinity and urge its full implementation.

Agricultural Education

India has made great strides in developing its system of universities, colleges and other training institutions to provide more adequately trained personnel to lead the nation's food production battle. But India cannot rest on her impressive accomplishments in this important field. The need is great to improve the quality of agricultural training, as well as to continue producing more and better quality personnel.

Improvement in the economic and other rewards which agricultural workers receive, upgrading the status of their work in society, and providing more widespread recognition of the crucial role they are playing in solving India's most pressing problems is essential to attract more high quality people into agriculture. It might be useful to provide more generous scholarships, fellowships, awards and other inducements to recruit the more able students into agriculture. Assurance of employment after completion of college work seems important also. For those already employed, and who are particularly able, fellowships for completion of under-graduate work (as in the case of VLW's), and for graduate work should be provided.

To make many specific suggestions on agricultural curricula would require more study than the Team was able to give. Nevertheless, we feel that the uniformity of agricultural college syllabi has doubtful merit. *We would encourage each institution to develop its own programmes based on the geographical area it serves and the problems of agriculture in the community.* More graduate work should be provided in India, but only at fully competent institutions. The Team has been impressed with the pioneering efforts of the Indian Agricultural Research Institute at New Delhi, and believes that this Institute may well set the pattern for sound developments in the field of graduate education.

In this connection, the Team expresses a word of caution. Instead of increasing the number of agricultural colleges and training institutions, it would seem desirable to expand and consolidate those already in existence. Where possible, agricultural and animal husbandry institutions should be located on the same campus to permit economies in teaching of basic courses and to encourage joint teaching of such courses as forage and feed production, animal breeding and genetics, and livestock production and marketing.

We are convinced that colleges with enrolments of a few hundred students suffer in effectiveness and quality. They often cannot afford the facilities, such as laboratories and libraries, nor the calibre of faculty, that a larger institution can support. In this connection the Team endorses the concept of the "Rural University" as set forth in the plans of the University Education Commission headed by Dr. S. Radhakrishnan.

CHAPTER VI—IMPROVING EXTENSION WORK THROUGH COMMUNITY DEVELOPMENT

Since Independence, and especially since the establishment of Community Development as a major Governmental effort, India has been making steady progress in improving the rural life of her village people. A social and economic development organization has been created and put to work across half the country. Thousands of workers have been selected and trained to undertake a job of tremendous magnitude and importance.

With respect to agriculture, the Community Development programme supported by agricultural and other technical department programmes, has undoubtedly contributed to the rate of increased crop production over the past 4 to 5 years. Fertilizer use has increased, and demand now exceeds supply. The production and use of improved seed has gone up. Plant protection measures have been gaining acceptance. Village cultivators are beginning to change to these and other improved practices where previously the traditions of centuries governed their actions.

This is progress in the right direction. It shows that the Community Development programme is making an impact upon village farming efficiency and food production. But much more must be done. A forceful programme of agricultural extension education must be forged and effectively carried on in the Community Development blocks and also in other "shadow" block areas.* This must be done with the close coordination and full support of the agricultural and appropriate other technical departments of the Centre and State Governments.

The mounting of an extension effort of the magnitude required calls for (1) an intensified and comprehensive programme focused sharply on food production, (2) a strengthened staff organization, effectively administered and trained, (3) the skilful use of a combination of extension methods that impel village cultivators to adopt improved practices in the shortest possible time.

1. EXTENSION PROGRAMMES AND THEIR DEVELOPMENT

A study of agricultural extension work demands that attention be given to: the adaptation of an extension programme to local needs; the degree to which the programme is directed to the particular interests of all people capable of making a contribution to increased food production; the extent of village cultivator participation in its development; the scientific validity of the practices recommended. Each of these points will be considered as they apply to India's present agricultural extension operations.

Determining the Block Programme

The basic problem of programming extension work at the village and block levels is one of determining in specific terms *what* is needed to increase agricultural production, who is to be involved, and what priorities of effort are required.

Community Development in India is not a programme, it is rather a generalized statement of aspirations. It becomes a programme

* Those not yet under the Community Development programme.

when translated into plans for specific actions in particular communities. "Grow More Food" is not a programme; it is a declaration of intent. To be administratively feasible and practically effective, such general goals must be translated into concrete activities, clearly reasonable and justified in terms of expected contributions to greater food production.

The content of block programmes to increase food production must be a function of locally indentified factors: the farm, its soil, the farmer and his family, their intelligence and educational level, their financial abilities and needs, their attitudes toward change, the resources of the community, and so on. The problems as well as their solutions must be defined in farm and village terms, for increases in agricultural production can only occur on individual Indian village farms.

Soils, managerial skills, financial resources and needs all differ widely. Many other factors combine to set each cultivator apart from his neighbour and each village from the next one. Hence, realistic programmes to increase food production require a discriminating and particularized assessment of local farming resources and potentials.

In the opinion of the Team, *present agricultural extension programmes in India would be capable of making a much greater contribution to increased food production if they were focused more directly upon local conditions, village production problems, and village potentials.*

Production Targets and Local Programme Adaptation

Ideally, national plans for food production should be based upon an analysis of the potential of each farm, taking into account peculiarities of soil, water, capital resources, skills and abilities of individual cultivators. But in preparing national plans, neither the data nor the time is available to follow this procedure. As a result, reliance must be placed on aggregate data and projections from them.

Figures thus derived may be reasonably accurate for the nation as a whole, but they hide tremendous local variations. The agricultural sector involves millions of independent decision-makers and wide differences in physical and social resources. This poses very difficult problems of data breakdown in order to reflect adequately the tremendous variations in local agricultural opportunities.

Where national targets have become part of the system of administrative evaluation, they may provide artificial and paper-oriented criteria for extension results, when the focus should be on real accomplishment such as additional food produced. Inevitably national targets are stated in aggregates of accomplishment, and they can give a false impression of widespread uniformity. When they are translated into local terms, they stress *means* (compost pits, acres under Japanese paddy, tons of improved seed, meetings held, demonstrations established, cusecs of water stored, etc.) instead of *ends*—the ends of increased production.

Targets also tend to over-simplify the nature of the problem of increasing food production. They imply that adopting a list of simple practices will turn the trick. They conceal the complex inter-relationship among many practices that is the key to increased

production. National targets may prevent the consideration of particular local needs and the setting of priorities locally, so that human efforts, funds and materials may be applied where increased food production may be expected to be greatest.

The Team believes that national and State production targets are necessary but that their use should be confined to the role of indicating national and State food and other crop requirements for the guidance of local programming, rather than serve as specific quotas handed down from above.

The Programme and the People

To be effective, a programme to increase agricultural production must take into account the people whose behaviour is to be changed and the factors that affect their behaviour or limit the possibilities of change. It would appear that *extension programmes in India have not given sufficient concern to the factors of human motivation.*

Food production objectives and programmes to achieve them must be related to the group that ultimately increases food production, the cultivators themselves. Unless the behaviour of this group can be changed, unless they can effectively be motivated to take steps which will increase production on their fields, no extension educational programme can succeed. From observations in the field, the Team believes that this fact is often lost sight of in the multiplicity of directives, campaign leaflets and procedures used in current extension work.

While the cultivator should be the primary focus of efforts to increase food production, farm women and youth can also make substantial contribution to greater farming efficiency and increased production. It appeared to the Team that these groups were not being given the attention that they merit in present extension programmes.

The Role of Women—Women play an important role in the selection and storage of seed and in such field work as planting, weeding and harvesting. New varieties may not be accepted because women do not like the grinding or cooking qualities of the grain. Women often share in the decision-making process when major expenditures are considered for such items as fertilizer. It is clear that village women are an important clientele to be reached, and that a great deal of teaching of agriculture can be done through village women's groups and training camps.

The Role of Youth—Even more important in the long run are the young people. They characteristically respond to group organization and action. They accept new and different ideas. Properly structured and organized, with provision for satisfactions and rewards, an organized youth movement can materially contribute to stated objectives in the short run and more specifically in the long run. Not only is there opportunity for the acquisition of skills directly by youth members but they in turn are influential in achieving change among their parents and others who come in contact with them and their projects.

India has made a beginning in several States in the development of Young Farmer Clubs. It is apparent that a number are contributing directly to food production. For example, clubs have utilized unused

land. By reclaiming and irrigation, they have provided garden vegetables and fruits for sale to the villagers.

Under the guidance and leadership of VLWs and local leaders, the young people learn new skills and understandings which are particularly valuable for those who are likely to remain in agriculture.

Youth clubs also may be useful in accepting certain community responsibilities now performed by other groups; members can be encouraged to become acquainted with other leadership responsibilities and functions in their villages such as panchayat and cooperatives.

In addition to the cultivators and their families, there are other groups whose activities influence or affect (more or less directly) the decisions of the cultivators. This includes the complex structure of Government agencies and their employees at the several levels, the cooperative societies, money lenders, warehousemen, and many others. How to influence these groups is not easily stated, but the point to emphasize is that the question of motivating them must be dealt with, if production goals are to be realized.

Involving People in Planning

Effective extension programme planning should involve not only the responsible administrative or official group effecting change but also the group that is to make the change. It is important that this latter group (the cultivators) take part directly in the process of indentifying their own problems, establishing goals, assessing resources, selecting alternatives, taking action and assuming responsibility for that action. From such a planning process, the professional worker develops a plan of work with goals that can be reached.

As the Team visited with State officials, district officers, block officers, and VLWs, it was apparent that only in a few instances had a beginning been made by the local people in taking initiative in programme planning. In some cases provision has been made for block advisory committees. Although these committees have representation from the villages, their leadership is under the control as well as guidance of Government personnel. It appears that most of the "planning" consists of assigning targets received from a similar district body and allocating resources for public improvements in connection with the Community Development programme. There is little evidence that this district group participates in developing an extension educational programme based on the needs of the people.

However, the Team observed that village leaders have been used in some instances to gain acceptance of goals assigned to the blocks. The procedure followed began with village circle camps. The Team noted that village leaders were trained in these camps to assist the VLWs and block officers by conducting subsequent meetings in their own villages. In a series of three such meetings in each village, problems are analyzed with the cultivators, production potentials are assessed, resources needed are determined, and finally cultivators pledge their intentions with respect to food production increases. It is noteworthy that where this procedure has been followed, targets have often been surpassed. We believe that if participation had occurred earlier in the planning process (instead of starting from goals passed down

from higher levels), production achievement might have been even higher.

Involvement of local people in planning processes is difficult and time-consuming. However, to meet higher production goals, and to achieve the objectives of human development and leadership, more emphasis must be placed on local participation in programme planning. It is clear that plans, not accepted by those people who alone can carry them out, are only paper plans. To project more fertilizer use where farmers refuse to use more fertilizer is futile. To plan for the activities which cultivators would do in any case is obviously wasted effort in India's critical food situation. Hence, there is really no alternative to increasingly effective local planning in which the cultivators themselves are involved.

As has been indicated earlier, the cultivators and other people of the village, as well as the professional staff, have roles to play in this planning process. Because of their training and background, the V.L.Ws. and block officers herein perform their roles as educators and guides in the process of planning for greater food production. In this connection, they can use statistically expressed targets from higher sources as guides to what is needed, to measure resources and to challenge interest.

Once production goals are set locally and methods for accomplishing them are agreed upon, the professional staff members can proceed to outline their own work plans for aiding the villagers to attain the stated goals. Ultimate performance, of course, is by the cultivators and they must be involved in the day-to-day actions and later in the evaluation of achievements.

Village Agricultural Production Committees

Various arrangements might be proposed to involve large numbers of local village people in planning and executing programmes. One alternative is organizing an agricultural planning and food production committee in each village. This committee might be made up of not less than five progressive, influential cultivators of each village. Such committees would have to be in close liaison with other village bodies such as the panchayat, the cooperative and the village school, and might be a sub-committee of the panchayat.

The function of the committee would be to help involve the cultivators in planning and executing the village agricultural production programme. The committee would work under the guidance of the block staff, receiving stimulation and direct help from the V.L.Ws. The members of these committees might be assembled on a V.L.W. circle basis at least twice a year for specific training related to their role of programme planning and execution. They could then report back to their villages, taking leadership in relating block planning to identified village potentials.

At one of these meetings, each V.L.W. circle group could elect one of their number to serve on a block agricultural advisory committee. Thus the block committee would number approximately ten cultivators. If coordinated planning on the various phases of community development is done at the block level, this committee would not be too large to constitute the agricultural sub-committee of

the overall block advisory committee. Representatives from the block agricultural advisory committees could also serve on district advisory committees.

We realize the kind of planning process here proposed cannot be adopted overnight. Its development will require time and patience. More importantly, it will require a change in thinking about the role of the people in extension programme planning. But a beginning must be made. *It is recommended, therefore, that initially one village food production committee be set up in each V.L.W. circle so that the V.L.Ws. and the block staff can develop the skills needed to expand this approach to the greater involvement of local people in food programme planning.*

Staff Work-Planning

There is also need for effective work planning by members of the block staff, as a group, on a long-range basis, annually or semi-annually.

If a V.L.W. is to plan ahead, he must know well in advance what demands will be made on him by the various block officers. Hence there must also be long-range planning by the block officers. For effective planning in the block, there must be long-range planning in the district, the State and the Centre so that "crash" programmes or last-minute memoranda on policy changes do not upset the local planned programme. At present, interference from higher levels contributes to village indifference by preventing active local planning. However, the final educational job has to be done at the village level and all planning should be geared to make this as effective as possible.

Many blocks now have an outline of the year's activities, but this is more a list of possibilities than an effective work plan, and at best it exists in a skeleton form. In most blocks there seems to be only limited planning on a fortnightly or monthly basis—plans for the next two weks or the month are developed at each block staff meeting. Moreover, there needs to be a more specific plan of work by the block extension officers and the V.L.Ws. to cover longer periods. Short-run planning leads to hurried activities, without prior notice of preparation for meetings or individual contacts on the part of the V.L.W.

The Scientific Validity of Programmes

In the final analysis, the real merits of an agricultural extension programme rests upon the scientific validity of the improved practices recommended to the village farmers. They must not only be correct and practical for an area of a district or block or V.L.W. circles, but they must also be sound when applied to the farms of individual cultivators. The Team noted that some fertilizer recommendations, for example, were made uniformly for large areas where there are variable soil fertility levels and soil management treatments. Such "whole-sale" recommendations may adversely affect food production and may waste valuable production supplies. Further, the making of improper technical recommendations can destroy the confidence of the cultivators in the local extension workers—confidence that the local extension personnel have taken great pains and skill to build up.

The answer to this problem lies in part with the V.L.W. and his technical training. But it more heavily rests with the several agricultural extension officers who support the technical programmes of the V.L.W. circles at block, district and State levels. Unless these extension workers maintain a constant liaison with the results of research field station trials and pass the information on down the line, they are not functioning in their proper role or living up to their technical responsibilities.

There is also clear evidence to show that a part of the problem arises from understaffing of specialized agricultural extension offices at all levels. Further reference is made to this point in the next section of this chapter.

Summary and Recommendations on Programmes

Agricultural extension programmes in India are not now having the impact upon food production that is necessary for the nation's survival. They can be improved. We therefore recommend:

1. The programmes should be focused more directly upon local conditions, village production problems and production potentials, and the village farmers should participate more actively in programme determinations, including setting the priority order of programme action. This process in itself leads to mental growth and development of leadership in village people.

2. Block extension workers should set up village food production committees through which the local farm people, assisted by block extension personnel and V.L.Ws., can, first, assess the present production and optimum production capacities of village farms; and, second, determine the combinations of improved farming methods necessary to achieve the production potentials.

3. Targets composed of improved practice quotas handed down to the blocks and villages from above should be discontinued. The use of targets should be confined to national and State requirements for key food and other crops and be used as guides by the local people and extension workers for programme planning for increased production.

4. Special extension programme emphasis should be given to the important contribution that farm women and youth can make in village community efforts to step up food production.

5. Caution should be exercised in making recommendations for any improved practice uniformly over large areas without adequate regard for their appropriateness for local farming conditions.

2. EXTENSION ORGANIZATION AND ADMINISTRATION

Beginning in 1953, the tremendous task of recruiting, selecting, organizing, training personnel, and staffing of 5,000 development blocks in India was begun. Half of the block units have now been organized and staffed, and it is planned to complete the task by 1963. The block unit was designed to serve an area with about 100 villages having a

population of 66,000 people. It has a staff of officers giving support to 10 village level workers, all of whom are expected to respond to the broad development needs of the cultivators and of the villages in all aspects of rural life.

By action of the National Development Council (June 3-4, 1957), the block was accepted as "the unit for planning and development" and the extension service as the agency through which the resources of Government were made available to the people. Thus the block represents the basic operational and administrative unit through which all activities related to community projects and agricultural technology come into focus on all aspects of rural life.

But organization and administration are not ends in themselves; they are means of accomplishing programme objectives. Within this framework, it is appropriate to examine the various structural units in relationship to the broad objective of increasing India's food production.

The Block Level as a Focus of the Programme

The basic idea of a block "team" of a group of officers having special areas of responsibility and functioning under the leadership of the Block Development Officer (BDO) is sound. But the multipurpose nature and function of the block makes for both strength and weakness. Strength is found in the integrated approach to progress at the block and village level. Weakness is found in attempting to be all things to the village people, and in possible deficiencies in staff relationships and organization.

Perhaps the most disturbing weakness at present is the extent to which rigid and distinct status barriers between the V.L.Ws. and block staff members and between the B.D.O. and members of his staff tend to prevent effective communication and to negate the far-reaching idea of the team approach.

The problem is intensified from the point of view of increasing food production because most of the B.D.Os. are not trained in and often have no experience with agriculture. Hence, if there is not good rapport between trained agricultural assistants and the B.D.O., if there is not full and free exchange of view between them, in which the B.D.O. becomes the pupil and the agricultural officer the teacher, programme administration is bound to suffer. We have noted that a B.D.O. who does not have an agricultural background may give less emphasis to food production than India's food emergency requires.

An encouraging development in some states is the recruitment of B.D.Os. from the supply of extension officers and especially from those with agricultural training.

The potential competition between activities to increase food production and other activities in the Community Development programme is reflected in the kinds of officers with which the B.D.O. is surrounded. At the block level, agricultural personnel is obviously outnumbered. While it may be argued that the animal husbandry and cooperatives block officers are also concerned with agriculture, what these officers actually do often bears only an indirect and long-run influence on increasing food production.

It is important that an organizational and team relationship be developed in the block that will complement and not compete with agricultural programmes.

There is need for a more careful analysis of the specific tasks which need to be undertaken in each block. This need arises out of the present uniform staffing and budget allocation for all organized blocks over India. Admittedly, the problems and opportunities vary from block to block and from State to State. Block staffing should reflect block resources, needs, problems and opportunities.

With the limited resources now available, it would seem imperative that allocations to blocks and within blocks be made on the basis of greatest potential results in food production. For increased agricultural output, one block might be considerably better situated than another, and would justify staffing and programming to maximize its contribution to solving the national food problem. In the aggregate, this differentiation between blocks might call for a reallocation of resources both within phases of agriculture and between agriculture and other community development programmes.

The long-range expectation should be for increasing the number of specialists and the level of specialization of block staff members so that the cultivators may have access to ever more highly developed technical educational aid.

Much of the world's progress in science, in technology, in production has come about through specialization.

How to apply intensive, specialized knowledge effectively to particular objectives such as increased food production is a problem of organization and administration. It is in this context that the concept of the V.L.W. and block staff needs to be examined, and alternative patterns of organization explored.

Important questions at present are:

—possibility of reassignments within the present block staff.

—possible effects of additional staff, either block officers or V.L.Ws.

—possible effects of group or village-approach versus the individual cultivator approach.

—criteria for the selection and staffing of new blocks.

The Village Level Worker

The broad objectives of the Community Development programme and of improving agricultural technology, as they come down from the many departments and organizations at the Centre, State, district and block levels, finally come to central focus on the V.L.W. to unify, coordinate and integrate everything into a programme for the villager. Even if he had the capacity to do the job, time would not permit him to do all the things expected. As a result, he has to choose among many possibilities.

It is only natural for him, therefore, to respond to those requests which are specific and recognizable, especially when his recognition and rewards appear to be based on his response to these requests. Thus, he may give only secondary attention to strengthening the resources and productive capacity of the cultivator.

The V.L.W.'s frustrations are many: too many items of work, too large an area to cover, treatment as an inferior, low pay, few possibilities for promotion, lack of quarters, supplies and equipment, and little or no assistance or guidance in planning and organizing his programme, etc. It is no wonder that there is a wide gap between what he is expected to do and what, in fact, he actually gets done.

Disregarding the multiplicity and diverse nature of the programme focusing on him and the lack of coordination from above, the V.L.W. can and does play an important role in this complicated scheme.

Perhaps too much emphasis is being placed on his being a multipurpose worker, in the sense of his having competence and expertise in technical agriculture, road construction, housing, cooperatives, etc. Although, he will acquire several skills, through both training and experience, his greatest opportunity lies in putting people who want to help themselves in touch with appropriate aid. This should become his specialized skill. He should aid in identifying their needs, fostering an awareness of needs, organizing people in relation to available appropriate aid. By the nature of his intimate contact and acquaintance with village people, he has the opportunity of effecting change toward both immediate and long-range goals. It is urgent that all superior officers recognize this as the V.L.W.'s basic task, and that the V.L.W.'s role be construed as one of service to the village rather than errand boy for those above him.

In the opinion of the Team, corroborated by Indian officials, many V.L.Ws. now possess greater aptitude and skill than other officers in working with people at the village level. Given the training in this task, he can become even more effective. To fulfil this role adequately necessitates a broad understanding of village problems, particularly in agriculture. Over-time he will need more and higher and constant upgrading. But the V.L.W. will still need the support and guidance of adequate and competent specialists at the block level.

It is widely established that the extension educational job can best be accomplished by a worker who concentrates his total efforts on his teaching function. Among the more onerous distractions from the primary educational job of the V.L.W. and other extension officers are the service tasks such as the procurement of seed and fertilizer, collection of fees, management loans, etc.

It is a temptation to say that the extension worker should slough off these chores, but often alternate ways of handling them are not available. Institutions for service may not exist. Moreover, performance of services may prepare the way for educational contacts. Often the services are of such a crucial character that withdrawal may cause a failure of the programme. *We can only conclude under the circumstances that such vital service activities be continued only for as short a time period as necessary, and that immediate steps be taken to develop other provisions for rendering these necessary service functions.* This point will be developed further under the discussion on the block officers, and elsewhere in the chapter dealing with cooperatives.

Although the general comments on the V.L.W. are more specifically related to the Gram Sevak, many of the general problems have application to and are shared by the Gram Sevika as well. Her

work is focused primarily on literacy classes for women, kindergarten and general home science education. Since the women of the village are involved in specific farm operations, an important contribution in improving understanding and training in food production can be provided by the Gram Sevikas. Close working relations for these Gram Sevikas on food production problems would be advantageous.

Extension Officers on the Block Staff

The concept of the block staff is that of specialists under the general guidance of the B.D.O. but receiving technical information from departmental district officers. The staff's principal function is described as providing assistance to the multipurpose V.L.W.

In this supporting role, the objective is that each officer should have a level of specialization for his particular assignment. Although each is a college graduate, his training is so generalized that only through additional training and experience can he assume the role expected of him. With the exception of the agricultural officer, the other officers have had training in such fields as liberal arts, science, law, veterinary medicine or education. Responsibility for the food production programme thus rests heavily on one officer. The need to upgrade his technical competence will become increasingly important as agricultural science progresses in India and as cultivators increase their technical understanding.

The perception which the block officers have of their own role, as reported to this study Team, suggests that they are more "action-oriented" than educationally minded. The block staff on the whole is an aggregation of workers in separate areas of work rather than a team focusing on problems. For example, the cooperative officer more often conceives his role as an organizer and auditor than as a teacher and counsellor on the purposes, objectives, opportunities and limitations of cooperatives. The animal husbandry officer seems to be concerned more with the services of vaccination, castration and of diagnosis of disease than in a programme oriented to food production.

The S.E.O.'s were unclear in defining their specific role. Except for the attention to literacy classes and drama groups, they seemed to perceive their role as preparing the way by organization and persuasion for development activities to be later led by other officers. This role is one which eventually all extension officers will share in common.

Since food production is a crucial need, it must command the maximum use of all staff resources. An example of the focus and organization needed, was reported by one B.D.O. who, in the Rabi campaign, assigned to each of his officers a sub-block area with specific follow-through responsibilities. With this sort of team approach applied elsewhere, a block staff could more nearly correlate other programme activities and at the same time provide the impact necessary on the principal objective. Both technical and administrative support from the district and State must be provided to make this possible in the blocks. In the meantime, there is opportunity to reallocate resources and assignments at the block level so as to give greater immediate attention to food production. We recommend the following changes in assignments for officers at the block level:

(a) *Agriculture Officer*: Relieve him of service responsibilities such as seed, fertilizer and insecticides, assigning these duties to cooperatives and the Cooperative Officer.

(b) *Animal Husbandry Officer*: Reorient his role to place greater emphasis on poultry and milk production where applicable, greater emphasis on forage utilization and controlled grazing which have more immediate impact on food production.

(c) *S.E.O. (Man)*: Assign him to the B.D.O. as a staff officer to assist the entire staff in organizing facilities, preparing materials, visual aids and other teaching techniques with particular bearing on agricultural production. To the extent of his time and abilities, he would train and assist the V.L.W. in organization, method demonstrations, etc. In this role, he would perform a staff function and would give service to selected programmes rather than carrying certain programmes alone. This idea is consistent with the objective that these skills eventually become common to all Extension Officers. It is, therefore, a step toward developing the organizational and methods competence of each staff officer.

(d) *S.E.O. (Woman)*: Assign responsibility for kitchen gardens and for education and training of village women in pertinent aspects of food production.

(e) *Cooperative Officer*: Assign him responsibility for teaching and counselling in regard to the purposes, objectives, and opportunities through cooperatives and aid in their organization. Make him responsible for the supply functions such as seed and fertilizer currently handled by the agricultural officer.

(f) *Other Officers*: Assign them responsibilities which would contribute more directly to food production, i.e., the panchayat officer should give leadership and assistance to organizing and servicing village food production committees; the engineering officer should aid in the construction of godown and farm-to-market roads. Training programmes may be necessary if such officers are to make their maximum contribution.

With the above reallocation of resources of the officers of the block staff, the agricultural officer will be free to spend greater effort in the educational tasks of food production. In addition, each officer will have an opportunity to make a more direct contribution to the immediate needs of food production.*

We fully concur in the recommendation of the report of the Agricultural Personnel Committee of the Planning Commission that "the block staff be strengthened by the addition of four agricultural graduates with some special training in selected subjects." Due to the lack of trained personnel to implement this realistically, this recommendation may be a long-range objective, at least for application uniformly across the country. However, priorities can be established so that as agricultural officers become available, they may be placed where they can make maximum contribution to India's food production.

* Elsewhere in this report, recommendations have been made for including other types of specialists at the block level—soil and water technicians, farm management specialists, etc. See Part III, Chapters VII and XV.

"Shadow" Block Areas

Present plans call for all of India to be served by a full complement of NES block personnel by 1963. Until that time a number of so-called "shadow" block areas (those not yet under the development programme) will continue to be staffed by an agricultural inspector, one or two assistant inspectors and possibly several kamdars, all of whom are responsible to State departments of agriculture through their respective District Agricultural Officers. These local department workers are making some contribution to greater agricultural production through the distribution of improved seeds and by advising farmers to some extent on modern practices.

But these shadow block staffs have not been kept fully manned in recent years and Government programmes of assistance to farmers in these areas have been reduced and neglected. Since the full-staff NES blocks were not selected on the basis of their farm production potential, undoubtedly there are a number of shadow blocks in good farming areas where production would respond to a full complement of agriculture personnel. To staff these shadow blocks with a full set of agricultural officers would make it possible to launch an extension programme effort which could be capitalized upon later when the area becomes fully staffed with community development personnel.

It is recommended that steps be taken to insure shadow blocks with full staffing of agricultural inspectors, assistant inspectors, kamdars, particularly in those blocks located in good farming areas. Attention should be given to the training of these men in improved agricultural practices and in extension teaching methods.

District Organization and Staff

The staffs in blocks and shadow blocks require support in the content of their programmes by technically qualified agricultural specialists located at district and state level headquarters. It is through these staffs of specialists that the latest research information on improved farming methods must be channelled to block extension officers, V.L.Ws and agricultural inspectors.

Apparently, only the agricultural officer is directly concerned with food production and his time is split between administrative and service duties on the one hand, and advisory or extension duties on the other. More of his time is devoted to administrative rather than technical areas of programme. As a result, the block extension officers and inspectors receive only a very limited amount of help on their extension programme in food production.

To correct this deficiency, the Report of the Agricultural Administration Committee recommended additional district extension specialists, their subject matter to depend upon the types of farming carried on in the various districts. The Team fully supports this recommendation and hopes that this can be implemented at an early date. As a shorter run recommendation, the Team suggests that the present duties of the district agricultural officers and animal husbandry officers should be re-arranged so that some of the routine administrative duties of these officers can be reduced and the servicing functions be transferred to the district cooperative officers.

A very important need at the district level is for a closer working relationship than presently exists between the specialists in extension and research. Obviously leadership must be provided at both the Centre and the State to establish and strengthen both formal and informal liaison opportunities. Special opportunities for this exist where research facilities are located within the district. This relationship between research and extension personnel should strengthen the content of the extension programme; the referral of field problems to research workers can be a factor in guiding research toward pressing problems in food production.

It is apparent that the agricultural and animal husbandry officers must work closer together as an integrated team concerned with total farm aspects of the block extension programmes—agronomy, animal husbandry and farm management—to increase total agricultural output. Special steps are needed to establish this coordination and integration. This is important not only between officers concerned with agricultural production but also with all extension officers at the district headquarters.

Organization and Staffing at the State Level

Several technical departments at the State level assist farmers in securing greater and more efficiently produced food supplies. It is through these departments that field personnel, including NES block and other staffs, secure the funds, production requisities, and irrigation facilities, technical assistance and extension education to aid farmers in food production. It is from the state technical departments that much programme leadership, programme substance and certain farm production facilities must reach the field in a coordinated and integrated manner.

Herein lies one of the problems in achieving increased output. There are too many independent agencies and organizations at the State level concerned with agriculture and food production. The problems of coordination and integration are obvious. Closely related to this situation is the lack of staff aides to assist department heads in making decisions. Coordination as well as decision making often comes easier where the ground work has been prepared by competent staff aides who have informally explored a subject, appraised alternatives and analyzed the relevant data and information.

One cannot escape noticing the strong emphasis on ideologically formed goals and rigid "formula" solutions proposed, some to satisfy ideological requirements rather than food production requirements. For food production there is need that programme and organization be pragmatic, emphasizing problem-solving and experimentation.

With respect to State-level direction, leadership and technical guidance for agricultural extension workers in the field, the Team supports the recommendation made in the Agricultural Administration Committee Report. It is important that each State promptly establish and fill with best qualified candidate the position of extension joint director. It is necessary also that several extension subject-matter specialists be posted with the extension joint director to guide field staff in a programme of extension education soundly based upon research.

These State extension specialists should work in continuous liaison with counterparts in research in order that research information be made available to the village cultivators through the field service, and that local problems retarding production be transferred to the attention of the research staffs. State extension units in agricultural departments should be confined strictly to agricultural extension functions. Responsibilities for supplies and regulatory activities should be transferred as rapidly as feasible to the cooperative and other appropriate departments.

Centre Government Responsibility for Agricultural Extension

The primary responsibility for agricultural extension programmes rests with the State Governments. The very nature of extension education requires that it be responsive to local needs. State direction and administration of extension work, therefore, is sound and should be continued.

However, the Centre Government must contribute to the conduct of State extension programmes, particularly at this juncture in history when India is building up the strength of the State services and is attempting greatly to increase the food supply.

The function that can best be performed by the Centre Government in giving leadership (1) in establishing and staffing State extension units, (2) in ideas and innovations about programme content and programme development, (3) in the use of all methods capable of making an impact on farmer understanding and adoption of improved production practices, and (4) in procedures for constant evaluation.

The effective expression of this leadership function depends upon the existence of a competent staff that keeps in constant touch with State extension operations and that has the ability to assist State extension personnel in analytical studies of problems retarding greater production achievements.

The Centre Government can also contribute to State extension service competence by keeping these services informed at frequent intervals on regional and national food supply and demand conditions. In addition, periodic progress reports of agricultural research findings generated by agricultural experiment stations throughout the nation can be prepared and sent to the State services with appropriate interpretation to supplement the findings of their own agricultural research.

At the present time, the Centre Ministry of Community Development and the Centre Ministry of Food and Agriculture's Directorate of Extension are performing the above function to some degree, along with providing supervision to village-level worker training and the preparation of agricultural production bulletins, pamphlets, posters and special campaign materials. These present functions should be continued but the broader, more fundamental task of agricultural extension leadership should be further developed.

The current food production emergency and the needs in the States for agricultural extension staffs, trained in the modern technology of agricultural production, places a particularly heavy responsibility upon the Office of the Directorate of Extension.

The Team recommends that some of the top-flght agriculturists be recruited to build up the strength of this Central Office for the duration of the current food emergency. The men selected should be nationally renowned for their competence in the production of the nation's key crops and also in livestock husbandry. They should be persons commanding the respect of their corresponding colleagues in research and also have the capacity to work with the State Directors of Agriculture in staffing and training competent State subject-matter specialists for the State services. A limited staff of this calibre could provide broad subject-matter guidance and overall programme leadership to the State Departments of Agriculture in their own efforts to strengthen block and district agricultural extension programmes.

Finaly, since agricultural extension programmes in the NES blocks are carried on by personnel under the administrative direction of the State Development Departments and under the general guidance of the Centre Ministry of Community Development, the staff of the Directorate of Extension in the Central Ministry of Food and Agriculture needs to continue and further strengthen the close liaison maintained with appropriate personnel in the Ministry of Community Development for purposes of administrative and operational coordination. The current effort to step up food production makes imperative the closest possible coordination.

Information Service: State and Centre

Mass media communications are among the most effective methods for creating "awareness" about an idea or practice. These methods also support the process of accepting and adopting new ideas. The potential of reaching large numbers of people through the use of such mass communication devices as radio, newspapers, pamphlets and other similar materials, movies, slides, film strips and other visual aids has not yet been fully exploited.

There are, of course, some major barriers to effective mass communication in India. Low literacy prevents the reaching of many cultivators through the written word. However, influential cultivators in many villages are able to read messages, at least, in simple form. Only a very small per cent of the cultivators have radios and community sets for villages are few in number. However, several programmes are under way to place sets in more villages, and the possibility of complete coverage is being considered. Experiments are needed to determine the impact of agricultural educational information material on cultivator-education and on agricultural production. Although newspaper circulation is low in the rural areas, we understand that newspapers do come to some families in many villages.

Since mass communications are among the means of conducting educational programmes, it follows that these means should be at the disposal of the agency responsible for the programme. Agricultural production is of importance enough and agricultural educational information is of such a unique character that we are impressed with a need to set up agricultural information services in both the States and the Centre. We agree with the principle partially accepted in some States that there should be a separate agricultural information bureau or unit in the Ministry of Agriculture and agriculture departments so placed

that it can serve as an aid to extension education. The unit should thus be an integral part of extension with guaranteed liaison to the research workers. It is important also that because of its special skills, the information staff help in the planning of action programmes and in using the most effective communication devices for success in action.

Three general areas of opportunity exist for an information unit:

(1) Preparation of material which is intended for the direct consumption of the cultivator and his family. Included in this are circulars, posters, radio programmes, press releases, etc.

(2) Preparation of materials to equip the corps of workers who do direct teaching: (BDO, ADO, VLW). Examples of this are handbooks, procedural outlines, campaign guides, supporting and additional technical information, film strips, movies and other teaching aids.

(3) Preparation of materials which will permit engaging the support from other Governmental and non-Governmental mass media sources. Groups involved include radio networks and newspaper and magazine editors.

On the production side of mass communication, we find that the State information offices are inadequately equipped, staffed and budgeted to take advantage of their present and expanding opportunities. Steps need to be taken which will:

(1) Provide additional information staff of editors, artists, radio and visual aid specialists.

(2) Provide additional facilities for posters, bulletins, circulars, radio tapes, transcriptions.

(3) Establish budgets for personnel and facilities on a continuing basis.

(4) Expand and improve the training workshops for State information staff; for State workers such as specialists, district level workers, BDOs, block officers and VLWs; for newspaper editors who can become more aware of their expanding opportunities to provide agricultural information to cultivators.

Specialized Administrative Functions

The organization, staffing patterns and staff coordination required to develop and carry on an effective agricultural extension programme—NES black to Centre Government levels—have been considered in the foregoing paragraphs. There are several special areas of extension administration, including budgeting, accounting and auditing and reporting, along with the management, supervision and training of the staff, that are also essential to the conduct of extension work. These elements of administration, with primary attention to block operation, are considered below:

Budgeting

One of the characteristics of block budgets noted by the Team is their high degree of uniformity, not only in the amounts of money made available, but in the purpose for which these funds are spent. Administrative uniformity may have some intrinsic merit. But it is

easy to adopt a pattern of uniform treatment in lieu of more careful and critical analysis of particular needs, perhaps offering the justification that uniformity of treatment is equivalent to equality of treatment.

However, it is apparent that the current budget pattern bears little relationship to block needs, block problems, or opportunities for block development. Often this system of budgeting requires that priority of time and money be given to such needs as roads, schools, libraries, community building instead of food production.

Under a system of uniform treatment, good agricultural areas get the same attention as the poor; areas from which India might expect to get substantial increases in production get no more attention than areas already producing near their maximum. Basic budget categories are determined at levels above the block, (thus putting the burden of justifying departures upon the block staff) and budgetary procedures restrict the discretion of block development officers.

While in a technical sense the B.D.O. has more authority than he usually exercises, the processes for gaining sanctions are so cumbersome as to stifle initiative. In particular, the procedure, used at all levels, requires double approval of budget allocations, first when the budget is prepared for submission to the legislature and then again after approval by the legislature. This procedure would seem to place an unnecessary burden on programme administrators.

In the light of these general comments, the following recommendations are offered:

(a) Block budgets for all aspects of food production programmes should be more flexible, and should, in total amount and in detailed breakdown, reflect priority programme needs and potentialities *as identified at the block level.*

(b) Budget procedures should be drastically simplified to permit more final decisions to be made at the block level without the delays now part of the complex sanctioning system. Similar reforms are also necessary at other levels, as has been pointed out in the recent Report of the Agricultural Administration Committee.

(c) Greater emphasis should be placed upon programme budgeting and on appraising expenditures in terms of programme accomplishments, than on elaborate and refined controls before expenditure. This emphasis on programme is necessary if the goal of rapid, flexible and effective food production programme administration is to be achieved.

Accounting and Auditing

Accounting for and auditing of public expenditures is no simple task. In all governments, there is a strong tendency toward preoccupation with details of financial regularity often at the expense of effective programme accomplishments. The administrator, who out of fear must be concerned with details of financial record keeping, cannot avoid having his initiative dampened and his enthusiasm dulled. While no one can advocate financial irresponsibility, it is important to recognize the adverse effects which too very stringent financial controls have on programme action and accomplishment.

The Team suggests that steps be taken to develop a fuller understanding of programme objectives in accountants and auditors dealing with emergency food production programmes. More particularly they must be made to realize:

(a) That programmes moving into new substantive areas move on untrodden paths; hence more numerous errors of judgment may be expected, and greater margins of error must be permitted,

(b) That where many new employees are being brought into a new and expanding programme, the chances for errors of judgment are increased, and hence a greater margin of error must be permitted,

(c) That the criteria for evaluating administrative financial decisions should include the standard of reasonableness of the action under the circumstances of the time and place,

(d) That the food production programme requires a high level of initiative and experimentation,

(e) That the overall basis of appraisal should be programme results that are a contribution to increased agricultural production.

Records and Reports

There is evidence that the quantity of records and reports required in an organization tends to increase geometrically with its size and complexity. This is especially true of a relatively large and rapidly expanding organization dealing with a new programme, since work patterns have not been established and supervisory staffs feel a strong need for being informed on what is happening at the points where the programme is being carried out.

It is easy for administrative systems to become preoccupied with records and reports for the purpose of mechanical paper controls and to lose sight of programme purposes, and the human individuals that must carry them out. Record and reporting emphasis, unless carefully analyzed, shifts easily from supervision and guidance to direction, command and inspection—in other words, to forms and orders and regulations, rather than to initiative and leadership.

Within this general context, the Team would suggest that appropriate representatives of the Community Development organization and others concerned should make an appraisal of the current reports and records required of the block staffs in order to determine the extent to which they make a specific contribution to the block and village programmes for achieving increased food production, rather than serve largely for administrative control.

A limited number of administrative reports relating to financial expenditure are, of course, necessary in connection with block development projects and service activities. However, it would appear that reports directed toward supervision and administrative understanding of extension results should be reduced to short, periodic and descriptive statements of programme achievement. With respect to the food production programme, *the focus of records and reports should be programme accomplishments toward the ultimate goals of more food.*

Beyond that, reports for administrative intelligence and overall programme appraisal need not go. For purposes of supervision however, worker reports also need to include a periodic review of teaching methods used, along with self-appraisals of the effectiveness of extension methods in obtaining programme results.

Management Procedure Experimentation

The Team has been critical of a number of current budgetary, accounting, auditing, and reporting procedures, expressing the view that these often hamper the realization of programme objectives. A number of general recommendations have been made to alter these procedures. It is suggested that an experimental approach be adopted with respect to these changes. A district area might be selected in each State in which greater control over budget allocation, without the need for superior approval, be given to the B.D.O.s. Accounting and auditing criteria might also be experimented with, and in sample blocks or village circles, the reporting requirements might be reduced to a bare minimum in order to determine the best ways to simplify and decentralize certain administrative operations that reflect upon food production programme effectiveness.

Personnel Policies

(a) *Job descriptions:* A job description prepared for each individual staff member, detailing the duties, responsibilities and authority for action, is a prerequisite to satisfactory performance. The Team noted that existing manuals, prepared *for* the block office instead of *by* the block staff, provide orders and regulations which are at a level of generality unsuited for specific guidance. The Team believes that more attention should be given to the preparation of job descriptions related to specific jobs to be done, and to the particular needs, problems and opportunities of individual blocks and village level worker circles. It is believed that job descriptions of this kind, prepared by the individual workers and their immediate supervisors, would provide greater understanding of the tasks assigned and of the performance expected.

(b) *Job tenure*: Sustained worker tenure is essential to effective extension education. The Team observed that there is considerable job turnover of block personnel. To a degree this problem is inevitable in the dynamic expanding activity of community development. But insofar as it is affected by controllable conditions, steps should be taken quickly to deal with these conditions, lest they continue to retard the quality of extension operations.

Among the conditions which the Team believes are contributing to job turnover are:

- Low salaries, especially when compared to roughly similar jobs in India generally.
- Lack of respect and status for agricultural employment.
- Insecurity in the job.
- Limited promotional and salary increase opportunities except by moving to other positions.
- Political influence in appointment in some areas.

The Report of the Agricultural Administration Committee refers to several of the above points and recommends steps to correct some of them. The Team would hope that corrective action can be taken promptly to remove all of the above listed causes of job turnover. In this connection, the Team has noted that the village level workers have limited opportunities for promotion to block extension officer positions and advancement up the line, since few of them have college degrees.

It would seem desirable for these workers to be offered college scholarships for outstanding service. Such a plan would be an incentive to effective work and an opportunity for individual talent to develop a fuller potential of competence in the interests of the nation's agricultural and community development advance.

A recommendation along this line has already been made in the Report of the Agricultural Personnel Committee. The Team fully endorses this recommendation and suggests that its implementation would not only add to the reservoir of trained men but would also serve as a powerful incentive to do good work. In addition, it would contribute to personnel morale.

(c) *Supervision*: Supervision can be defined as the task of giving guidance and counsel to help achieve staff growth and development. It involves both administrative, or personnel management, and technical aspects. In the blocks, the extension officers are supervised administratively by the block development officers. Technically most of the extension officers are also under the supervision of their technical superiors at the district level. This same situation exists in the supervisory relationship between the village level workers and the block extension officers.

Dual supervision occurs in many organizations but it is often a cause of worker confusion, irritation and frustration unless a high degree of staff coordination is present at each supervisor level, i.e., at the block extension office level with respect to supervision of the village level workers, and at the district office level with respect to block staffs. A complicating factor exists in the rigid lines and status distinction of Indian public service between administrative and technical services.

There is need for a more realistic recognition of the limits of coordination and of the need for and importance of individual choices and decisions which are then translated into action through supervision and guidance. This is an especially acute problem where persons with differing technical training are involved.

For obvious reasons, far-reaching changes in this system are probably not immediately feasible. But it would seem desirable to make careful studies of this problem and to experiment with alternate patterns of arrangement, perhaps on a pilot basis in a number of sample blocks.

Extension worker competence depends heavily upon adequate and skilful supervision as well as upon more formal pre-service or in-service training. The Team has observed considerable variation in the attitude of the different block personnel regarding their role of supervising the village level workers. In several blocks visited the block staff viewed their supervisory job as that of issuing directives

and orders to the village level workers and then making inspections of what work the local staffs had accomplished. In other blocks the B.D.O. and extension officers considered their supervising function to be that of giving counsel and guidance to the local workers, of helping them analyze problems impeding effective work, and also showing concern and giving advice on local living conditions and other personal matters.

The Team believes that a higher state of village level worker performance, and of extension programme effectiveness in achieving greater food production, will occur where supervision is viewed in the latter light. Block officers and also district officers should be encouraged to develop this positive and staff developmental side of supervision.

(d) *Training*: Training the vast number of staff to man the community development programme in a relatively short period of time is a tremendous task. The rapidity with which India has expanded her training facilities has been phenomenal. This Team has been impressed by the way in which a large number of Government departments have been involved in building new institutions, setting up syllabi, staffing the institutions and training various types of extension workers. From the standpoint of achieving greater food production, competent agricultural extension workers, trained in technical substance and in extension teaching methods, are a prime need.

The Team did not have the opportunity to make a thorough study of the strengths and limitations of the present training programme. However, the Team is aware that several reports, among them the Report of the Agricultural Administration Committee, the Report of the Agricultural Personnel Committee and the Fifth Evaluation Report on Working of C.D. and N.E.S. Blocks, have given the training of various levels of agricultural extension personnel careful scrutiny. The Centre's Directorate of Extension is also giving continuous study to ways and means of upgrading the training of village level workers.

As a general observation, the Team believes that India needs to look to the future training of village level workers, block officers, appropriate district officers and others most directly involved in the drive for increased food production, with several criteria in mind. With special consideration to the need for greater food production, staff training of extension workers, including women workers, needs to consider (a) integration of the training programme now widely dispersed, (b) more specific attention to who is trained, (c) the specific purpose of the training, (d) the content of the training in terms of getting more food produced through extension work, (e) the methods used in training, (f) adequacy of training for specific job assignments.

The need for an improved training programme is mentioned in many places in this Report. In this section a few observations and recommendations will be offered for the training of block personnel who have a basic job to do in aiding farmers grow more food.

(1) *Block Development Officers*: For those B.D.O.s who do not have an agricultural background, additional training must be given in the field of agriculture and extension methods. There is also need

for training all new B.D.Os. in the field of democratic administration and supervision.

(2) *Agricultural Officers*: The attempt is made to secure agricultural college graduates for these positions. Unless the status of the professional agricultural workers is raised, the best students will not be attracted to the agricultural colleges. There is a need for more agricultural specialists for teaching, research and extension. The suggested pattern of agricultural specialists at the block, district and State levels makes this need even more imperative. The present system of using a common general syallbus does not allow for subject-matter specialization. There should be flexibility to allow for specialization in the various agricultural sciences and in the problems singular to the areas served by the colleges. For those college students who intend to enter extension work, provision needs to be made in the college curricula for courses that will be of special use to them, for instance, extension methods.

Before taking a job in the block, training is necessary in the philosophy of community development and extension methods related to agriculture. Induction training under a good agricultural officer already in the field should be encouraged.

(3) *Animal Husbandry Officers*: The same comments made on college training in the paragraph above apply to the animal husbandry officers. In addition, if these officers are to perform the duties suggested earlier in this chapter, they must have additional training in animal breeding, feeding, management and in the proper care of farm animals. The same general type of orientation training and induction training should be given to animal husbandry officers as to the agricultural officers.

(4) *Cooperative Officers*: If the cooperative officers are to perform more of the agricultural supply "servicing" recommended earlier, they must have additional training in basic agriculture, the role of credit in agricultural production and in organizing and administering farm supply and farm product marketing functions. They also need the training that will enable them to conduct successful co-operative member education programmes.

(5) *Women Social Education Officers*: The women social education officers carry on certain activities directly related to food production, food preservation and preparation. Since women SEOs are the immediate supervisors of the Gram Sevikas in a technical sense, it is imperative that their pre-service and in-service training include subjects relating to the work of the Gram Sevikas in the fields of agricultural production, home food storage, family nutrition and so on.

The Team gained the impression that present training of women social education officers in the above areas is very limited and superficial. It is recommended that training syllabi of these officers be re-evaluated in terms of the present food production emergency with a view of strengthening the food production and family food preservation subject matter presented in training courses (both pre-service and in-service).

(6) *Gram Sevaks*: The Gram Sevaks have a primary responsibility for the motivation and stimulation of farmer interests in extension education directed toward increased food production. They must

also have a reasonable degree of knowledge in the skills of farming and in farm management and the methods of informing farmers about improved practices, as well as in methods of involving village farm leaders in developing a programme to step up food production.

The Team had only limited opportunities to study village level worker training programmes. However, it appears that some of the training given is highly theoretical and abstract. A way must be found to bring some of the more successful block agricultural extension officers into the instructorships for Gram Sevak training. As to the practical training of Gram Sevaks in village circles near the training centres, these training circles should be staffed with experienced successful Gram Sevaks in order for the trainees to secure practical teaching skills that will help them when placed in their own village circles.

(7) *Gram Sevikas*: The important contribution of farm women in increased food production has been referred to in an earlier section of this report. Since the Gram Sevikas are the local extension officers most directly in contact with the village farm women in their respective circles areas, they have a significant role to play in the nation's drive to step up food production.

Pre-service and in-service training of the Gram Sevikas now gives limited attention to the growing of vegetables in kitchen gardens, the home preservation and storage of foods, the care and feeding of dairy cattle and poultry, preparation of family foods—all subjects capable of having an impact upon the nation's food supply. Training given to Gram Sevikas in many of the above areas appears to be limited in actual work-training experiences.

The Team strongly recommends that steps be taken to improve the training programmes of the Gram Sevikas, both in terms of content that will better prepare them to aid farm women in their food production tasks, and in terms of actually performing the improved farm and home practices that they will later be expected to demonstrate to the village people.

In addition to what has been said above about block staff training, it is to be noted that continuous in-service training is essential through short seminars, training conferences and tours as well as through adequate and positive supervision. Such meetings and tours can best be conducted by extension subject-matter specialists at the district and State levels. This provides an additional reason for the placing of more specialists at these levels in order to give the continuous block staff training needed during the critical food emergency.

3. EXTENSION METHODS

Extension education seeks to secure desired changes in human behaviour by initiating, stimulating and guiding people in the process of education and motivating them to take desired actions. Extension methods are the devices used to create situations in which communication can take place and bring about these desired behaviour changes. Effective use of extension methods can make a major contribution to motivating the cultivator to increase food production.

Many different kinds of extension methods are being used by Indian extension workers. Other methods are available for use. However, it is believed that India's extension programme could be

much more effective if there were a clearer understandings of the basic knowledge and skills needed for effective extension methods. The body of knowledge that is available from the disciplines of social-psychology, sociology, educational psychology and cultural anthropology is being only partially used. This lack of understanding appears to exist with those who train the professional workers. In many cases, they can verbalize the concepts but have little real understanding of them and of their interrelation, and are unable to make practical field situation applications. Thus, it is understandable why those actually working with the villager do not have adequate understanding and skill in using extension methods.

There are many understandings and skills needed to educate and motivate people effectively. The Team observed a number of areas where there is great potential for increasing educational effectiveness. The following areas, with examples, are given to illustrate the point.

Understanding Social-psychology

The extension worker needs to have the understandings that will enable him to determine the mental make-up of the cultivator with whom he must communicate. In approaching and working with people (and choosing methods), much more attention needs to be given to such things as their values, attitudes, aspirations and perceived needs.

The extension worker should be able to do a more effective educational job if he secures the following kinds of information about the cultivator. What is the cultivator's perception of the extension worker? Is he seen as a friend, and outside exploiter, a person who must prove himself, or a person with sound practical information? What are the cultivator's attitudes toward changing his ways of farming and what is the basis of these attitudes? What does the cultivator see as his problems and why are these things problems? Does the cultivator have aspirations to farm better? Does he think he can improve his farming methods? In many cases one of the first steps in the educational process may be to convince the farmer he can, with his limited resources, do a better job of farming.

These are examples of the kinds of information that should enable the extension worker to better understand the cultivator and do a better job of communicating.

The Learning-Acting Process

There needs to be greater understanding of the learning-acting process. For instance, even an oversimplified conceptualization of this process should be of great aid to the professional worker in bringing about desired change in a cultivator. The process can be thought of in terms of:

Awareness — Attention. Knowing about the practice but not understanding its intrinsic qualities.

Interest — The desire for and the receipt of more detailed information on the practice.

Evaluation — The mental process of weighing the advantages and disadvantages of the new practice over the traditional practice.

Trial — The physical trial of the new practice on the land.

Adoption — The process of interpreting and evaluating the trial results which lead to rational satisfaction with the trial and commitment to use.

It is granted that these are not neat mutually exclusive stages. However, the recognition of these as elements of a process is important in planning the educational attack. Within this framework specific methods can be chosen that will produce the most efficient results. It should also make the extension worker realize the great difficulty in completing the entire process with a "one shot" approach. It gives a guide for continuing education.

Many new practices are being recommended for adoption. We assume that they are applicable to the cultivators to whom they are recommended. However, the relatively high number of cultivators who revert from new practices back to the old traditional ways is an indication that some of the basic criteria of the learning-acting process are being violated. A suggested hypothesis is that the cultivators do not understand the basic "why" knowledge about the practice, do not carry out the trial in the proper manner under proper conditions and are not aided in accurate interpretation of the trial.

The Villager in His Social Setting

There needs to be greater depth of understanding of the social setting in which the villager lives, communicates and acts. Many programmes, and workers, assume that the village is an integrated community when in reality it may be made up of many factional groupings. There is a tendency to oversimplify the complex leadership, power, influence and communication networks that exist in the village.

There is, for example, often the assumption that since the head of the panchayat is the elected official of the village or his area, he is the real leader in a political and social sense. He may not be. There is also the additional assumption that if he is the real leader in the political and social sense he also is the leader in agricultural influence. This is not necessarily the case. If he is not an agricultural leader it is quite understandable why extension workers do not secure rapid adoption among neighbours when demonstrations are carried out on his farm.

It is highly probable that more efficient educational activities could be carried out if greater attention was given to analyzing the social groupings and group influences of such groups as family, neighbours, friends or other special interest village groups. Understanding these groups may enable the extension worker to use the group approach in teaching to reach more people effectively. Convincing an influential leader in the group may set the atmosphere for teaching other group members or result in a direct spread of the practice to other group members.

One often sees a directive to place a demonstration on the farm of a large, outstanding cultivator. Such a demonstration may serve

a real purpose by leading a certain group of cultivators to adopt the practice and making many other farmers aware of the practice. However, if the "smaller resource farmers" are to be reached, the demonstration may have to be placed on a farm very similar to theirs in terms of physical and financial resources and managerial ability. It is through this process that the "smaller resource farmers" can perceive the demonstration as applying to them and certain modifications can be made in the practices demonstrated to take into account their more limited resources.

The Communication Process and Extension Methods

It is only by gathering such basic background understanding and skills as these mentioned here that effective communication situations can be set up. With this kind of knowledge the extension worker can do his best to adjust himself to the communication situation. He should be able to choose his approach more effectively, the *place* to start, the *intent* of his message, the *content* of his message, the appeals to use, the *timing* to use and the amount of follow-through needed.

This kind of background knowledge also provides the context within which the choice and use of various extension methods have the greatest possibility of succeeding in getting the cultivator to produce more food. Hence, we recommend:

(a) Instructors with competence in extension education must be secured or trained for the extension wings of colleges and the various training centres.

(b) A syllabus covering the psychology of learning and character of group action should be developed as soon as possible for in-service training programmes. It should also include methods of teaching. Instructors must be trained in the content and use of the syllabus for training the various levels of workers.

(c) A planned programme of in-service training should be developed and initiated as soon as feasible with the objective of increasing the understanding and skills of all levels of workers in using this type of knowledge on the job. The first priority of training is probably with people at the block level—B.D.Os., other block level officers and V.L.Ws.

With the above as a background, there follow here the Team's specific comments about the use being made of selected extension methods as observed in the field.

Individual Contacts

Personal contacts with individual cultivators and their families are known to be one of the most effective extension teaching methods. It is only with the kinds of understandings and skills suggested in the previous section that these contacts can be most effective. The individual contact method provides the greatest opportunity for the extension worker to know the cultivator, his problems, his attitudes and aspirations. The worker can develop a deep understanding of the particular technical and management problems of the cultivator and thereby keep in touch with the practical needs farmers face under different conditions.

Personal contact also helps the extension worker size up the potential of individual farmers as capable leaders through which the efforts of the professional teacher can be multiplied. This method also provides the greatest opportunity for the cultivator to become personally acquainted with the local extension worker and the extension programme, and thus to determine in what ways the worker can help him improve his farming operation.

The greatest limiting factor on the use of personal contact is the amount of time it takes. Therefore, an important consideration is choosing the people to contact who have the greatest potential in influencing food production. The V.L.Ws. have more time to make personal contacts than the block extension officers, but it would be highly desirable for the block officers to accompany the V.L.Ws. in some farm visits in order for them to share the practical nature of these experiences. The accusation was often made, as we toured the blocks, that district and higher officials have lost touch with the farmer and his problems. They too could probably profit from these individual contacts with cultivators and different size farms. We recommend:

(1) Personal contact should continue to be used as an important extension educational method. However, because of its time-consuming quality, it is important to use intensive personal contacts with those cultivators who have the greatest potential in helping increase food production, directly, or indirectly through influencing other cultivators.

(2) Block and district agricultural officers must make enough personal cultivator contacts to keep them in touch with the practical farming problems of cultivators.

Result Demonstrations

Result demonstrations appear to be one of the teaching methods most widely recommended and, when properly used, one of great effectiveness in India. The Indian farmer bases his decisions on what in his mind has been clearly proven to work. Related to the low literacy rate in India is the cultivator's difficulty and distrust in dealing with abstract ideas from word of mouth or the printed page. His experience world, his world of proof, is what he can actually see and experience. Thus the demonstration, when properly carried out, should provide a successful educational experience.

Some excellent demonstrations were seen in India. However, many of them could have greater educational value. In trying to meet the imposed target many demonstrations are set up without proper consideration of what to demonstrate, the importance of demonstrating practices in combination, the importance of controls and the use of demonstrations for the greatest educational impact. The demonstrations set up by research workers, specialists and in many cases block agricultural officers were usually well set up and carried out. However, many of those set up by V.L.Ws. did not reach their potential. This would indicate that additional training and supervision needs to be given for demonstrations set up by V.L.Ws.

There is often not enough follow-through on the demonstrations. There needs to be more recognition of the importance of helping the cultivator observe and evaluate the demonstration at critical teaching

times. The importance of helping the cultivators go step-by-step through observation and evaluation, and structuring thought patterns toward future commitment to adopt, cannot be overemphasized. If anticipated results are not obtained, it is equally important to evaluate and interpret the possible explanations for this fact. The improper interpretation of results by the cultivator can do much to destroy the cultivator's trust in the specific practices demonstrated as well as in future recommendations.

Much more educational value could be obtained from the successful demonstrations now being used. A single successful demonstration shown to groups of farmers at critical teaching times will probably have greater educational impact than a greater number of relatively poor demonstrations conducted on individual farms. The accumulated results from successful demonstrations could be used by the extension staff to a greater extent as teaching material with other farmers. We, therefore, recommend:

(1) The use of demonstrations as a teaching device should be encouraged. However, steps should be taken to make sure that they are set up properly. Additional training and supervision is needed in the case of demonstrations set up by V.L.Ws.

(2) Whenever possible emphasis should be placed on the demonstration of the proper combination of practices.

The Group Approach and Group Techniques

The great number of cultivators to be reached dictates that much of the educational programme will have to be carried on through groups. Major emphasis seems to have shifted from total village involvement to the individual approach. Between these two extremes there appears to be much opportunity for work with smaller groups, say the 10 to 40 person group. At best, the present group approach seems to be based on a rather casual hit or miss basis, working with a group that gathers around the V.L.W. in the village or moving into a circle of cultivators visiting in the village or in the fields. The group approach requires the organization of groups around a special interest. These special interests may be on the basis of specific crops or problems, size of farm, economic resources, level of practice adoption, locality of fields or living, etc. There needs to be additional understanding and use of the process of group formation around special interests.

Within this small group framework the two major group techniques that are now most used are talks and discussions. If used properly, these techniques should be successful in helping accomplish certain kinds of objectives. However, it is the belief of many people in the field, and of the Team, that workers need much more understanding and training in the use of these techniques. A number of V.L.Ws. say that one of their most difficult problems is how to give a good talk in front of villagers. Many of them say that they are very insecure in leading discussions. This insecurity stems from two major sources: (1) lack of subject-matter competence to handle the questions raised and (2) lack of skill in handling a discussion group.

If the group approach is to be used more effectively and if there is going to be increased use of the group approach, there are many

other group techniques that may prove effective. With certain kinds of groups and objectives the following techniques should have real value: panels, interrogator panels, symposiums, dialogues and interviews. In some cases drama and puppet shows are being used for educational purposes. It would appear, therefore, that role-playing could also be successfully used as a teaching techniques. We recommend:

(1) Additional use should be made of the small interest group approach in educating and motivating farmers.

(2) A study should be made by the syllabi committees to determine the efficacy of increasing the training on group formation and group techniques for the various levels of extension workers.

(3) The possibility of in-service training in this area should be investigated.

(4) The recommended group techniques could be utilized by skilled people who have charge of the various refresher courses and workshops that are now being held and thus demonstrate their use to the participants.

Leader Training Camps

The use of Village Leader Training Camps as an educational method is to be commended. The Team was very favourably impressed with the camps visited. Proper use of this type of training of leaders in agriculture may aid greatly in maximizing the limited resources of the block staff. The holding of village Women Leader Training Camps with at least some portion of the camp instruction devoted to the women's role in making decisions on agriculture and food consumption patterns is also commended.

As future camps are planned, additional attention needs to be given to:

(1) The selection of leaders that will have the greatest impact on agricultural production in the villages. This assumes they will have influence with other relevant groups of cultivators by example and overt educational attempts with their neighbours and have a spirit of responsibility and service to their fellow cultivators. To date many of the leaders chosen do not seem to meet all these criteria.

(2) The reaching of different leaders in subsequent camps or planning the content of camps to take the same set of leaders progressively through different and perhaps more complicated areas of content.

(3) The planning of the camp programme and its content so that the greatest educational impact can be obtained with the camp. This calls for the best use of all types of educational methods and well-planned and solid content material. (In one camp we saw an excellent method demonstration set up in the camp with a follow up of the demonstration with cultivator involvement in practice in the field.) There appeared to be an over-dependence on the talk method with no involvement of the cultivators in meaningful learning experi-

ences. The proper use of resource people from the cultivator, block, district and research levels should be encouraged. There could be much additional use made of visual aids in the educational process. The proper use of influential cultivators in planning, convening, giving information and making presentations and touring cultivators' farms should be encouraged. Giving the cultivators recognition and status for attending these camps should lead to other cultivators seeking to be invited to the camps.

(4) The possibility of utilizing the trained leaders as a part of a team to conduct village level camps, perhaps more limited in scope, should be tested out.

Two major weaknesses of the camps seem to be apparent:

(1) Trying to include too broad a subject-matter content. In some cases there appears to be the philosophy that all block officers should present something on their phase of the programme. Even within agriculture, in most cases it is more important to do a good thorough job on a more limited number of ideas than to attempt to cover too many areas.

(2) Follow-up. Several VLW's indicated that they did not take time to really follow up with the cultivators to:

(a) see if they had adopted the new ideas presented,

(b) see if in reality they had attempted to inform, demonstrate to or influence other cultivators. The leaders chosen were assumed to have "followers." In some cases an attempt was made to get the leaders to "commit" themselves to help carry on the educational process with other farmers before signing them up for the camp.

We recommended that:

The adoption of the Leader Camp idea at this stage of the educational process seems to have great potential. Camps should be encouraged. In terms of their importance and the amount of resources that are used, great care should be used in planning and executing them to assure maximum educational impact.

The Campaign Approach

During the past year India has used the campaign approach in several States to stimulate a greater production of Rabi season crops. Almost universally this technique is again being tried to step up the production and yields of the 1959 Kharif season crops. The campaign approach is a valid method to achieve a concentrated effort toward any objective when applied judiciously and with adequate preparation. The value of the campaign technique in the drive for more food production lies in its wide-scale mobilization of all appropriate resources on a limited number of improved practices and crops. The technique is also a means of calling the attention of the total population—most important of all the village cultivators—to the critical need for greater food production. Finally, the campaign method can achieve a considerable measure of operational coordination and cooperation among the various agencies involved in the provision of credit and production requisites when directed towards a specific set of goals.

It is evident that the 1958 Rabi campaign achieved a measure of success in stimulating more production. The greatest limitation of the 1958 campaign effort was undoubtedly the lack of adequate preparation in terms of providing production supplies where and when needed, and in terms of training block staffs and village leaders in how to apply the practices covered in the campaign. Lessons learned in the Rabi campaign should be used to insure greater success in the forthcoming Kharif campaign.

The place of the campaign approach to step up food production in India over the next several years should be studied with extreme care because the method has certain limitations. (1) It should be recognized that campaigns are only supplements to a total educational programme. Campaigns tend to focus on a specific set of practices or crops. Other extension activities must provide the knowledge needed for a well-rounded educational programme. (2) The realistic potential of increasing food production through the use of campaigns must be evaluated against the large amount of resources needed to carry out the campaign. (3) The strong initial impact of the campaign technique cannot be sustained over a considerable period of time. The campaign method should be used intermittently, not continuously. (4) The campaign approach should be used only after there is a clear indication that ample supplies are locally available to permit the cultivators to follow through. (5) The campaign should be restricted to top priority crops but with emphasis upon a complete set of practices that will insure maximum results. (6) Adequate planning with special consideration given to timing must precede the launching of a campaign. (7) Between the intervals in which national or State campaigns might be launched and actual launching, district or block initiative should be permitted to determine readiness and applicability of the campaign approach to local conditions.

Visual Aids

The effective use of visual aids such as movies, film strips, slides, flip charts and posters should increase the productivity of agricultural education efforts. A part of the problem of prepared visual aids should be solved by providing adequate Centre and State agricultural information services.

However, a number of problems do appear to exist at the block level:

(1) Many blocks do not have adequate equipment such as projectors and cameras with film.

(2) There do not seem to be adequate general or specific agricultural education films, slides and film strips.

(3) Adequate equipment and materials are not available in the block to facilitate the production of visual aids such as posters, flip charts and flannel board materials.

(4) The visual aids that do exist are not used to the extent and in a manner that will produce the greatest educational impact.

(5) In some blocks agricultural officers report difficulty in getting to show agricultural films because of the priority given to documentary and entertainment films.

We, therefore, recommend that:

(1) Immediate steps should be taken to provide additional agricultural visual aids, and visual aid equipment and materials for use in the block.

(2) Agricultural educational films, film strips and slides should have top priority in village educational programmes.

CHAPTER VII. SOIL AND WATER CONSERVATION, INCLUDING WATER USE

India has the natural resources and the labour supply for at least twice her present agricultural production within the framework of democratic government and using primarily its present sources of draft power in the fields. As a broad generalization, one may say that the problem of food production is a problem of bringing about proper combinations of soil, water, plants, and people for production.

This is what many people mean by the term "soil and water conservation"; although to some it has the narrower connotation of "saving soil and water from waste" through excessive runoff, erosion, waterlogging, salt accumulation, soil blowing, spoiling of good soil by earth removal, overgrazing, clear cutting of trees, and the like; and the reclamation of soils injured by such wastage.

Actually, India cannot afford programmes of soil and water conservation in this narrow sense, except for the protection of reservoirs and other works of improvement. The agricultural problem is not one of maintaining, but of *developing* soil productivity to the highest practicable level and of maintaining it at that level. What we seek in agriculture is not any kind of *natural* balance, but the highest level of *cultural* balance that modern technology and social organization make possible.

The physical resources of soil, water, and climate are sufficient to yield at least double, perhaps more than double, current production with full use of machines, chemicals, and the other products of industry. Full mechanization will not be practicable for some time nor is it necessary to meet food requirements. Agricultural labour, however, is at hand and can be employed much more usefully than now without great increases in mechanical power.

Specialization

India has a wide variety of soils, responding differently to soil and water management practices and having different capabilities for many kinds of products. Then too, water supplies vary widely in the country. Thus, within the limitations of transport, it is possible to make further adjustments in local cropping systems for specialization in the crops best adapted to the local soils. Due regard must be paid, however, to the superior results often obtainable by rotating crops or by using mixed cultures and for local requirements of grain, vegetables, fruit, fuel, and animals for power.

Combined Practices

The principle of combined practices is one of paramount importance in planning soil and water conservation. No one practice is good over a wide range of soils. Nor can we usually expect the adoption of any single practice, by itself, to give an economic result. The big harvests come from *combinations* of practices adapted to the particular situation. Thus one must avoid the "easy way" of emphasizing some one or two practices above all others in a "campaign," because the results are bound to be low for the effort. For example,

bunds alone, fertilizer alone, improved tillage alone, or improved seeds of potentially high-yielding varieties alone, may each give a small uneconomic increase on good soil under dryland culture; but the *combination* commonly gives a three- to six-fold increase in the harvest.

Although single-practice demonstrations can have a limited usefulness in some situations, of greater importance and value are demonstration of combinations. Actually, the cultivator always uses some combination, perhaps a poor one, but always a combination. It is the good combinations that he should select and that need to be demonstrated and economically evaluated, if the cultivator is to make an intelligent decision among the alternatives open to him.

The Cultivator Makes His Arable Soil

Actually all natural soils are modified by agricultural use. The cultivator makes an arable soil from either a natural soil or one already modified by use. Rarely do even the most primitive people cultivate soils without any practices to improve or to maintain them. As agriculture becomes increasingly efficient through the use of science and engineering, we are less and less concerned with the productivity of soils when first ploughed. Rather, we are more and more concerned with their potential productivity in response to combined practices. Among the most productive arable soils of the world today are a high proportion that were nearly worthless in their natural state or as modified only by land clearing and tillage.

The point is especially important in India, since *most tropical soils are not highly productive under simple management. But many of them can be made so by the cultivator's art as improved by science and aided by the products of industry. It is thus that a strong and efficient agriculture develops with a strong and efficient industry.*

The "Ideal" Soil

The aim of cultivator should be to use those practices that give the most nearly ideal soil for the crops best adapted to his situation. Each practice needs to be evaluated as it fits into the combination of practices and as it contributes toward producing the ideal soil. Broadly stated, this soil should have :

1. An adequate rooting zone so that roots can range over a large volume of soil for water and nutrients.
2. Good tilth for root extension, water penetration, and air movement.
3. Adequate water in the soil, as supplied and stored from rain or irrigation, and without excess that excludes air.
4. Surface protected from soil blowing, erosion, or excessive runoff.
5. A balanced supply of plant nutrients in relation to other growth factors and specific plant requirements.
6. Freedom from harmful pests and weeds that harbour in the soil.
7. Freedom from excesses of salts and from harmful acidity or alkalinity.

The broad purpose of research, education, technical assistance, cost sharing, and public works in the field of soil and water conservation is to help cultivators develop and maintain their arable soils for maximum economic returns.

In the development and maintenance of arable soils, the control, use and disposal of water are intimate parts of any successful management scheme. Both soil and water are used together. The individual cultivator is commonly severely limited in what he, by himself, can do about water control. For much of the irrigation, drainage, and runoff control essential to good soil use, many cultivators must work together.

1. WATER SUPPLY

Over the greater part of India, 80 per cent of the annual rainfall is received in the 4 months of June, July, August, and September. Since India has a tropical or sub-tropical climate, it has a potential to grow crops the year around; an adequate water supply in the soil can provide opportunity for increasing crop production several fold. Either too much or too little water and its inefficient use are presently primary limiting factors in India's crop production.

India is blessed with one of the largest water supplies of any country in the world, but only a small portion of its potential has been developed. Opportunities lie both in irrigated and non-irrigated areas. While the total land area in India is slightly over 800 million acres, the amount cultivatable is approximately 350 million acres. The total irrigated area in India from all sources in 1951 was approximately 51 million acres. The figure given today is slightly over 56 million acres. By the end of the Second Plan, it is estimated that 87 million acres will be receiving irrigation. Eventually 150 million acres may be irrigated, about 75 million acres by multipurpose projects, and another 75 million by other categories of irrigation.

India's source of irrigation water supply is from (a) stream flow with direct diversion or from surface storage, (b) shallow masonry or tube wells and (c) irrigation tanks.

Stream Flow and Surface Storage Water

The primary purpose of any irrigation water is to provide a reliable source of water for crop production so that the available soil, plant, and climatic resources can be used to their full extent. The supply of irrigation water, therefore, should be both timely and adequate in amount. In a country such as India, where much of the river flow is seasonal, this requires storage either above or below the ground surface if water is to be available on a year-round basis.

A mere statement that a given amount of acreage is under irrigation has little meaning without knowledge of the conditions of irrigation. For example, land irrigated by a stream flowing only during the monsoon season may be classified as irrigated land; yet during the monsoon season farmers may need irrigation water only once in several years. Such lands should not be confused with those areas irrigated from storage reservoirs or tube wells where water is available for irrigating 2 to 3 crops per year.

In determining the feasibility of projects and the cost of irrigation, it is essential to relate the cost of irrigation to the benefits to be derived in terms of physical crop yields and related social benefits. The current system of determining the merits of a scheme in terms of irrigation charges alone may not be conducive to good irrigation development.

While the diversion of water from seasonal stream flow may be the cheapest way to irrigate a given acreage during the flow time, for total crop production it may be better to supplement such diversions with storage or wells or by wells alone, depending on the local water supply.

Where surface storage of irrigation waters is feasible, or where the flow of streams provides sufficient water on a total crop season basis, such methods of irrigation are usually the most economical. The potential area that can be irrigated from these waters appears to have been well evaluated and plans for their development have either been made or are under consideration.

Recommendation 1: Continued emphasis should be given to the development of irrigation water supply through storage reservoirs and direct diversion from rivers and streams where water delivered is based on a continuous yearly supply.

Well Water

Where stream flow is only seasonal, during monsoons, and where storage reservoirs are not feasible, consideration should be given to the possibility of providing the crop requirements with shallow masonry or tube wells for irrigation.

As a general rule, there is less loss of water in conveyance and evaporation when wells, rather than canals, are used as the source of water. The supply is closer to the user. The problems associated with the timing of delivery or demand by the farmer are much easier to cope with. Wells give an opportunity for a wider selection of crops to be grown, since the water requirements of each crop can be readily met.

Some people emphasize that river water, because of its silt content, is superior to well water for irrigation. This difference, however, is almost everywhere insignificant in modern agriculture with the adequate use of fertilizers. Very sandy soils can be improved by additions of silt, although the fertilizer value of silt is negligible.

In 1952, the Government of India entered into an agreement, "Operational Agreement Number 6," with the Technical Cooperation Mission under the Indo-American Aid Programme for the construction of some 2,000 tube wells in the Punjab, U.P., and Bihar. Later, this was increased to some 2,885 tube wells. An excellent report is available summarizing this endeavour.

The report indicates that as a general rule throughout this area, there is no problem in developing tube wells of 1 and 1½ cusecs capacity of good quality water. This report further indicates that farmers using these tube wells are getting from 45 per cent to 100 per cent

increase in yields—in spite of the fact that a change-over to multiple cropping and crops best suited for irrigation has not been universal. Also the farmers have not had access to proper fertilizers. The percentage increases in crop yields are accredited to the single factor of irrigation water.

Throughout this region there are large areas growing only one crop per year. The programme for the Second Plan does provide for construction of 3,581 tube wells. This is a small number, however, when considered in relation to the needs of all of India. There can be no doubt but that real opportunities for increased production lie in the development of more wells where they are feasible, and such areas are widespread.

For example, in the Arapanch Drainage Scheme near Calcutta, where some 25,000 acres have been drained, now only one crop of paddy is grown per year. Good quality underground water for irrigation is available near the surface. With tube well irrigation this area should be able to produce 3 crops per year. It already has drainage, and land levelling would not be a major problem. In addition to most of the Gangetic Plain, there are similar areas in Madras State and Andhra Pradesh. The Geological Survey of India has considerable knowledge of underground water resources in all States and is accumulating additional information.

Recommendation 2: The tube-well programme should be greatly expanded in those areas where there is now a relatively sure supply of good ground water. This would include large areas in Uttar Pradesh, Punjab, West Bengal, Bihar, Madras, Andhra Pradesh, and parts of Bombay and other States. Those areas which have potential for 2 and 3 crops per year should have highest priority.

Although the more shallow masonry wells can each irrigate only a small acreage, for the most part they use an indigenous wheel with bullock power, and most of the requirements of construction and power can be met within the village. But wherever ground water availability has been firmly established, and the depth of water table is below 20 to 25 feet, consideration should be given to the more economical tube well development.

Recommendation 3: The programme for shallow masonry wells should be expanded to meet the maximum demand consistent with good irrigation planning.

Irrigation Tanks

Approximately 10 million acres in India are irrigated by tanks. There is opportunity for economic construction of many additional tanks. It is not uncommon to find tanks that are too shallow, with depths of only 2 to 4 feet. This situation not only requires more land to store an adequate amount of water, but it also provides both extra surface for evaporation losses and extra area on the bottom for seepage losses.

Wherever seepage is a problem, soil samples should be studied for possible ways of compaction or chemical treatment to reduce it. (See Recommendations No. 15 and 29 in this Section of the Report).

2. IMPROVED WATER MANAGEMENT

Water Conveyance

Regardless of the source of water, it must be transported at least some distance before it is finally applied to the field. The problem of conveyance, therefore, becomes real under any type of irrigation. The publication Better Use of Land, by the Ministry of Community Development, states that :

> *"In many irrigated areas, half of the water diverted from the rivers and streams is lost in conveyance and half of the water given to the fields is lost before it gets to the roots of the plants."*

The more serious seepage problems are found in the large surface projcts. This is almost universally true where the canals are not lined.

Recommendation 4 : Seepage studies should be made in the canal systems losing more than 15 per cent of their water. Where excessive seepage is occurring, action should be taken to reduce it.

Probably the most intriguing conveyance problems are those within the village and on the farms. A description of this tremendous problem in India was given by Beleshwar Nath, Secretary, Central Board of Irrigation, in his paper presented at the International Commission of Irrigation and Drainage, Third Congress, May 1958. His paper states :

"In proprietary areas in the Punjab and Uttar Pradesh, water courses are mere ditch drains. They are irregular in shape and follow unsatisfactory alignments as cultivators want to drag them as near their own holdings as possible. Length of the water courses are undefined. In some cases, on each outlet, they run to an aggregate of many miles. At many places they are crossed by village cart tracks and often wastage of water is noticeable at such crossings. An improvement of these water courses is often sought through the cooperative effort of the cultivators themselves. But, as is often the case, outlets serve people from different villages and different groups with varying interests according to the location of their holdings with regard to the outlet head. It is, therefore, difficult to mobilize cooperative action in such cases. The result is a perpetual state of unsatisfactory water courses.

"The general pattern of field formation is irregular. It has grown as population has grown. There has hardly been any change ever since the first settlement operations, that took place some centuries ago. As a result of such irregular configuration of culturable plots, the water courses have to follow tortuous courses and suffer many bends and kinks. The water from the outlet head has to traverse a longer distance than what would be necessary, had the fields been formed in proper geometrical formations. Besides, the fields are not levelled up, which results in more water getting accumulated in one part of the field than the other."

It must be recognized that the seriousness of the problem does vary from one area to another, and that on some of the more recent irrigation projects, including the project on tube wells, water courses are laid out in a more geometric pattern. The fact remains, however, that for the most part, little or no technical assistance or guidance is being given to the farmer to assist him in developing efficient water

courses, to say nothing of technical assistance and guidance in helping to devise the best kind of farm channel constructions. The solutions of these problems alone would be of great help in aiding increased food production. They will have to be solved some day. The sooner the better. (See Recommendation No. 29 in this Section of the Report.)

Water Application

The problems of water application in most Indian villages are enormous. Even though for the most part, the land holdings are in small plots and extensive labour is used, proper land preparation is not made. While most methods of irrigation, such as level border, borders with varying degrees of slope, furrow, and even sprinkler, may be found, most irrigation is a type of the wild flooding method modified in some cases with small furrows or borders.

With this kind of irrigation, the distribution of water is not uniform and so crop yields are not uniform. There is excessive leaching in some parts of the field and not sufficient water in others. This lack of sufficient water over large parts of the fields is the more important. Proper land preparation would do much to increase agricultural production in most irrigated areas. For the most part, the time of application is determined by the period when water is in the canal or on some other basis. It may or may not have any relation to crop needs. (See Recommendation No. 29 in this Section of the Report.)

In many of the irrigated areas water is available for more than one crop per year. Yet a recent survey has shown that only about 12 *per cent of the land under irrigation has more than one irrigated crop grown per year.* Even on the one irrigated crop, the use of adequate fertilizer and good seed are the exceptions rather than the rule.

While the highest possible agricultural potential for a given climate and soil occurs where irrigation water is available, to get high production requires more than just water. It requires the combination of other good management practices. As a general rule village farmers are not using the good practices in combination necessary for high production. *Yields as low as one-half ton of wheat per acre are common in irrigated areas* where a few farmers may be getting 1½ tons per acre. Comparably poor yields of other crops are common.

Probably the greatest opportunity for immediate increase in food production lies in the improvement of water management, fertility, and cultural practices on lands now irrigated, where opportunities for 2 to 3 crops a year exist. Immediate steps should be taken to provide both technical and financial assistance to the farmers in order that adequate systems of water conveyance and distribution may be provided. Land levelling and proper preparation for uniform distribution of water should be included.

India can make greater and more immediate gains in food production by intensifying expenditure of time and effort on water management than by constructing large-scale irrigation projects which take years to develop. The Third Plan should allocate substantial funds for technical assistance to aid cultivators in making better use of available water.

It also will be necessary for this assistance to cover the problems

associated with the disposal of waste water. Technical guidance should be provided on the types of crops that will give maximum economic returns, the amount and type of fertilizer and of irrigation required for these crops.

With the limited supply of fertilizers available, priority should be given to those areas which meet the conditions mentioned above. It will be on these areas that maximum return from fertilizers will be experienced. *Unless fertilizers are available, the improved water management practices will not give maximum returns.* Additional fertilizers must be made available for the areas in short supply, so that amounts recommended for high production can be used.

*Recommendation 5: A number of villages should be selected in irrigated areas for an experimental programme using all the best known water-management practices, necessary fertilizers, recommended seeds and cropping systems, and good cultural practices combined into a farming system.**

From the discussions above it is apparent that good agricultural practices such as proper conveyance systems, land levelling for uniform water application, proper cropping systems, and adequate fertilizers are not now being used on most irrigated areas. When new land is brought under irrigation the villagers will have all of these problems as well as others with which they are not familiar. It is a slow process for a farmer to change from non-irrigation farming to irrigation farming unless the benefits of irrigation farming are effectively demonstrated to him as well as the practices necessary to obtain these benefits.

If the change-over is to take place speedily, the farmer and villages must have timely research to determine the best adapted practices, and timely education, demonstration, and technical guidance to get the best practices in use on the land. In most cases, subsidies, either in the form of non-interest loans or direct payment to help pay the immediate cost of adequate land preparation and water transmission structures, would also be required.

Money is generally made available directly to the Irrigation Department for the construction of irrigation projects. On the other hand, no adequate funds are provided, from the large funds spent on major irrigation projects, for the necessary research, demonstration, and technical assistance required to get maximum benefits from the projects in terms of production.

It is now estimated that irrigated fields produce only one-fifth to one-fourth ton more food-grains than unirrigated fields. This is an extremely low return on investment in irrigation. But this estimate is used by Government in projecting benefits from new irrigation projects —an indication that good agricultural practices are not even expected on newly irrigated lands. Some provision, therefore, must be made in planning for future irrigation projects to make available the necessary funds to carry out responsibilities in the sphere of research, demonstration, and technical assistance in the command areas.

Recommendation 6: An adequate percentage of the total cost of each new major irrigation project should usually be earmarked and

* See Part III, Chapter XV, for a fuller discussion of pilot experimental projects.

made available through appropriate agencies of the Agricultural Department, to start their educational and the necessary technical work on irrigated lands at the same time that the engineering construction phase of the project is begun. This would include research and demonstrations (using water from wells or tanks) as long in advance as possible.

A general programme should be developed to train people to give technical assistance in the field of water management. *A two-to three-month irrigation management school could be set up at various locations where 15 to 20 qualified trainees could be assembled.* The instruction should be primarily through demonstrations of actually applying good water management practices on farms. If the right people are selected (possibly the educated unemployed) for the training, 2 to 3 months should be sufficient to prepare them to give considerable guidance and technical assistance to farmers in problems of conveyance, land levelling and the amount of land that should be irrigated at a given time with given supply of water. (See Recommendations No. 27 and 29 in this Section of the Report.)

There are a number of places in India where research and demonstration experiments are being conducted on problems of irrigation. Most of these are underfinanced and understaffed. Consequently, the needed information relating to proper timing of irrigation, methods of water application, the proper amounts of fertilizer, and the combination of these with good seeds and other cultural practices is not being obtained over a wide enough area or a rapid enough rate.

While it is highly desirable that there be sufficient research experiments and demonstrations to cover all important soil and climatic areas, it is even more important that those that are developed have adequate trained staff and sufficient funds for equipment and operation. It is better to do a good job in a few places than be extended so thin that only inadequate results are obtained.

Recommendation 7: Research experiments and demonstrations should be greatly expanded to deal with the proper combinations of (a) water management, (b) fertilizers and green manures, (c) good seeds, and (d) other cultural practices necessary for high production.

Surface Drainage

Much of India's agriculture is handicapped by excess water during the monsoon rains that frequently create major problems of surface drainage and contribute to waterlogging, especially when combined with perennial irrigation. Drainage problems are especially acute in Punjab, Eastern Uttar Pradesh, Northern Bihar, West Bengal, and in the lower portions of river deltas.

In some areas water may remain on the land from one monsoon season to the next. Considerable damage is also caused where the surface water remains on the land for only a portion of the year. This not only adds to the sub-soil water problem, but also may drastically reduce crop growth during most of the year.

A good example is the National Dairy Research Institute at Karnal in the Punjab. As late as February of this year some of the land was still wet from the last monsoon season. Much of the cropped area was waterlogged to the extent that crop production was probably

not more than 25 per cent of what it would have been without the excess water. The primary cause of the magnitude of the surface drainage problem is the interference of flow capacity in natural drainage-ways by roads, railroads, and irrigation canals. Paths made by farmers and villages also add to the problem.

There are places in India where it would be possible, by surface drainage, to reclaim and use large areas for cultivation which are not now productive. The portions of these areas that appear to be most productive and that have the possibility of 2 to 3 crops a year should be given highest priority.

In the Punjab alone, for example, it is stated that waterlogging exists on some 3 million acres of land, and a serious rising water table on at least an additional 3 million acres. Natural surface drainage channels have been cut off by the grades of canals, railways, and highways. An immediate programme should be started in the Punjab, and other States having similar problems, to provide adequate surface drainage.

The irrigation and drainage people in the Punjab are doing some work on these problems and they have some major drainage plans. *The programme should be given a much higher priority for development and be put on the land at a much faster rate.*

The problem is so important that some one agency, which has responsibility in, at least one phase of the problem, probably the Irrigation Department, should be given the responsibility for broad coordination and improvement of natural and artificial drainage ways. The agency should have authority to enforce regulations prohibiting the interference with flow capacity of drainage ways. Plans for the construction of highways, railroads, and canals should enhance drainage, not interfere with it.

Recommendation 8 : A single agency should be given the responsibility for coordination and improvement of natural and artificial drainage ways, and improvement of natural drainage ways should be given a high priority.

Salinity and Internal Drainage

Both salinity and internal drainage are two major problems associated with irrigation agriculture. Since these two problems usually occur together they are discussed together.

All irrigated land must have some provision for adequate drainage. This is true since all irrigation water and most soils contain some salt. It is necessary, therefore, that water be leached through the soil from time to time. The amount depends upon the salt content of the water, the salt content of the soil, and the quantity of water required for crop production. Some soils have adequate natural drainage; for others artificial drainage must be supplied.

Seepage from canals has been the cause of large areas going out of production, but in only a few projects have drains been installed to relieve the waterlogging. Where such drains have been constructed, they are commonly placed in regions where the water is nearest to the surface and not at places that would intercept the water source.

Apparently, there are very few places in India where drains were

constructed prior to the actual waterlogging of the soil. It is much easier to prevent waterlogging and its accompanying salt and alkali problems, than it is to reclaim the soil after they have developed. In many cases salt and alkali problems are not adequately evaluated, since their harmful effects develop gradually. First the yield is reduced slightly and then to greater and greater extents, and finally complete crop failure results. Commonly, only the final stage is recognized.

A study has recently been made in the States of Punjab, Uttar Pradesh, West Bengal, Bombay, Orissa, and Mysore to determine the extent of drainage and waterlogging. The findings of this study are available in the Central Water and Power Commission (C.W.P.C.).

A recent study, available in C.W.P.C., reports that some 3 million, 2 million and 2½ million acres of land in Punjab, Uttar Pradesh and West Bengal respectively have a water table within 5 feet of the surface. An additional 3 million acres in Punjab have water tables at 5 to 10 feet depths. A considerable portion of these areas grow either no crops or very poor crops. We have found there is considerable controversy as to the reliability of these figures. The Team, however, believes the problem is of sufficient importance to warrant further investigation.

There is need for an early survey of saline and alkali areas, and of both the surface drainage and waterlogging problem areas, in all States where the existence of such problems is suspected. Not all saline and alkali areas have been caused by irrigation. The same general phenomena can and have occurred naturally, with waterlogging and salt accumulation. And the remedies for such areas are about the same; internal drainage, leaching, and the addition of gypsum on the alkali areas. But commonly these areas are difficult to reclaim because of insufficient water for leaching.

Waterlogging investigations should be initiated in all irrigated areas, and in those non-irrigated areas known to have the problem. This should be done by installing a series of observation wells where the ground-water level can be followed throughout the year. In areas where the ground-water level gives indications of rising too high, corrective measures should be taken before salt and alkali conditions develop. Adequate surface drainage should be provided for before tile systems or other internal drainage is provided.

Recommendation 9: Research and demonstration should be expanded on the reclamation of saline and alkali soils and increased efforts should be made to reclaim present areas affected by salinity and alkali.

Bunding and Terracing on Dryland

Of the 150 million acres which may some day be irrigated, it was noted earlier that by the end of the Second Plan only an estimated 87 million will be receiving irrigation water. This leaves, at least for the Third Plan period, over two-thirds of the cultivated area dependent upon erratic rainfall, which is commonly insufficient for profitable food production.

Any substantial improvement of these dryland areas depends on improved management of the rainfall. The present great losses of water do double damage: the water is lost to critically needed food production and runoff causes serious damage by soil erosion. These

damages have already been very great in India. Considering the needs in this country, further damage is intolerable.

Every State has this problem of water management on non-irrigated soil. Perhaps special mention should be made of the Central Indian Plateau, the Deccan Plateau, the high lands of southern Bihar and of Orissa, the undulating parts of West Bengal, the plains of Rajasthan, the hills of Assam, and the mountain slopes of the Punjab and Uttar Pradesh.

Potentially good soils exist in large parts of these areas that can be made much more productive by contour bunding, either directly on the contour or at a slight angle to it, depending on the permeability of the soil in relation to rainfall intensity. Much work in India has fully demonstrated that this bunding, if properly done, results in (1) higher crop yields directly and higher potential responses from fertilizer and superior seeds, (2) more intensive farming, such as changes from rough grazing to cropping or from single-cropping to double-cropping, (3) reduced erosion, and (4) improved supplies of water in adjacent wells. To be effective such bunds must be laid out accurately and not compromised with field bunds.

Recommendation 10 : Increased effort should be made on accurate contour bunding with first priority on better soils (1) that can be shifted from rough pasture to cropland, (2) that can be shifted from Kharif crops alone to both Kharif and Rabi crops, or (3) that can produce much higher yields.

Several factors are preventing the further development of this work where the results would be highly significant: (1) inadequate educational preparation for village schemes by extension officers, (2) fragmentation of holdings, (3) cultivators' preferences for "field" bunds, (4) compromises with field bunds so that the results are ineffective, and (5) inadequate laws for handling bits of land belonging to non-cooperators who leave serious gaps in the system.

It has been said that field bunds are better than no bunds. For many good sloping soils that respond greatly to contour bunding, field bunds are actually far inferior. Field bunds on such soils can even lead to harmful waterlogging or erosion by concentrating the water, where it lies to spoil the crop or breaks through the bund to cause a gully. The promotion and construction of field bunds can have the effect of seriously delaying a proper bunding scheme.

Field bunds on nearly level soils are useful when the areas they enclose are levelled for uniform water distribution and penetration, provided also that drainage is adequate to avoid waterlogging.

Recommendation 11: Legislation should be adopted to provide that a bunding or terracing scheme be undertaken in a village, or larger unit, only where a clear majority have voted for it with full understanding of the works to be done. The work should be done on all land required to make the scheme successful and charged as part of the taxes against the land if necessary. *The Government should maintain the bunds for 2 years, after which the responsibility for maintenance should be given to the village.* In order to protect the welfare of the majority, the Government should inspect the bunds thereafter and make necessary repairs if any bunds are not maintained, charging the cost as part of the taxes against the land.

It must be emphasized that different types of bunds are needed in different situations of slope, soil and rainfall. No standard pattern can be laid down for all soils. For example, on some very heavy soils with swelling clays, broadbased bunds, with long back slopes are helpful to avoid great cracks which form in the dry season and lead to serious leaks and breaks when the rains come. Other soils require only narrow bunds of 5 to 6 feet at the base.

Additional benefits accrue from contour sowing between the bunds, along with very low temporary bunds made after ploughing and before sowing by a simple bullock-drawn bund-former.

Where soil material is highly erodible, the bunds should be protected with grasses that may be cut for fodder, or grasses such as *Sacharum munja,* that have other special uses.

Some soil cannot be successfully bunded by earth bunds that are made from surface soils which do not become firm. In many instances proper bunds can be made from the subsoil, but not from the surface soil. *Such specifications need to be made clear in any contract work.*

On some important sloping soils, earth bunds that will hold cannot be made from the soil, partly because of its granular nature. Yet good results may be had from stone terraces at reasonable cost. Practicable development of urgently needed cropland from sloping red soils with stone terraces may be seen in Kerala. Such work needs emphasis.

On very permeable soils of steep slope, earth terraces with back slopes can be made where the high returns justify the costs. On some highly permeable strongly sloping soils of moderate productivity, quite good results at much lower costs can be had with small earthen bunds that are stabilized with permanent grass. This grass not only helps stabilize the bund but also serves as a "silt" trap to build it up. In the drier areas, Euphorbia, sisal, and similar low hedge plants can be used.

On many soils, levelling or partial levelling between bunds can be helpful by giving a large surface for the intake of water. Results in India have shown greater increases in yields when combined levelling and bunding are used than when either practice is used alone. Then too, where water is available, the areas between bunds can be levelled for irrigation, provided that the soil is adequately drained, either naturally or artificially, for the crops to be grown, and provided that such levelling does not bring kankar, rock, laterite, or other unproductive materials close to the surface.

But above all, bunds on sloping soils should be laid out accurately in relation to the contour. For this reason it is highly important to coordinate contour bunding schemes with land consolidation, as has been done so successfully in some Indian villages. (See Part II, Chapter I, Sections 2 and 3.)

3. SOIL FERTILITY IMPROVEMENT AND MAINTENANCE

The improvement and maintenance of soil fertility are vital parts of any useful scheme for soil and water conservation, especially in India where most arable soils have developed under tropical climates. A first step is, of course, to discover the actual plant nutrient

requirements for productive efficient use. Even where protection is the chief objective, say in catchment areas of non-arable soils, the establishment of protective vegetation requires at least some moderate level of soil fertility to have the most economic combination of both protective *and* productive plants.

Nearly all the soil and water conservation work in India, however, is directed primarily at the production of forage, timber, and especially food crops. The control of erosion and other soil wastage is incidental to this main objective, not an end in itself.

A good start has been made in several parts of India toward assessing the nutrient requirements for alternative systems of use, especially through the soil-testing scheme. Unhappily, however, large areas are without significant results from approved laboratory soil tests or fertilizer experiments. For such areas, as for example in the hills of Assam, simply designed trials on cultivators' fields can give first approximations for an early definition of the problem. Exploratory studies of plant nutrient needs can be carried out cooperatively with soil surveys and should be an integral part of any serious undertaking of soil and water conservation in areas lacking such information. Without proper attention to soil fertility, regardless of whether the nutrient deficiencies are corrected by chemical fertilizers or in other ways, the success of the whole undertaking can be jeopardized.

The higher the costs for special works, such as drainage, bunding or terracing, and especially irrigation, the more vital soil fertility improvement is to the success of these works. The aim of irrigation should be to do a good job of water management and thus eliminate moisture deficiency or excess as limiting factors in crop production. *To make irrigation works pay out, plant-nutrient deficiencies must also be eliminated.* Similarly, adequate economic returns from contour bunding and terracing depend upon parallel improvements in soil fertility.

The assessment of nutrient requirements of the soils, and their correction by chemical fertilizers and by other means, need further continued emphasis in soil and water conservation research stations, demonstrations, and project areas. Many of the research trials of the Soil Conservation Research Stations, both under the Soil Conservation Board and under the State departments of agriculture, must include fertilizers to have meaningful results.

Once the nutrient needs are known, there are several ways by which they can be met. Usually some combination of the following is employed: farmyard manure, compost, green manures, wood ashes, and chemical fertilizers. Although they are strictly soil amendments, we must also add agricultural lime to the list for acid soils and agricultural gypsum for alkali soils. Only very rarely can the nutrient needs of tropical soils be met economically without at least some chemical fertilizer. A fuller discussion of this point is given in the following chapter on Chemical Fertilizers.

Composts and Farmyard Manure

In many States active programmes have been started to reduce the waste of manure and other materials suitable for compost. The manure can be used directly on the soil without composting where

the proportion of straw and other carbohydrates is low. It is hoped that further development of village or farm fuel trees will reduce the use of cow dung for fuel and leave more for application to the soil.

Wood Ashes

Wood ashes have great value also, especially on acid soils and where potassium is deficient. Among other crops, these are commonly used on coconuts; but additional amounts of potash fertilizers are urgently needed for coconuts, especially on sandy soils.

Green Manuring

Many States also have active programmes for promoting trees, shrubs, and other plants that can be grown in field boundaries, along roadsides, and in other uncropped areas for green manure. Additional possibilities exist for green manuring crops in the rotation but most farmers cannot sacrifice for this purpose land and water needed for food crops. The promotion of green manure plants that do not compete with crop plants for space and water deserves great emphasis in the immediate future.

Chemical Fertilizers

The Team feels so strongly on the need for great emphasis on this aspect of soil and water conservation that it is dealt with separately in the following chapter on Chemical Fertilizers.

4. TILLAGE PRACTICES

In several places in India commendable steps have been taken to develop improved ploughs, harrows, seeders, bund formers, and other implements, many of which can be made by village carpenters and blacksmiths. Good follow-through is needed on the experience of farmers with such implements *on different kinds of soil* to appraise their effectiveness.

Power-driven machines must also be given increased attention where good possibilities exist for their efficient use by individuals, groups of cultivators, or cooperative societies on a custom basis. Several typical situations where tractor-drawn equipment is needed are the following:

(1) For bunding, levelling, and ploughing of massive clayey soils that cannot be properly handled by bullock power. Some potentially useful soils have been avoided previously, simply because bullock-drawn tillage machinery is ineffective. Some of these soils will, perhaps, need only occasional machine ploughing; others will need at least annual tillage with strong tractors.

(2) For ploughing of clayey soils that are difficult to handle when the time for preparation between crops, or after heavy monsoon rains and before sowing, is too short for effective results by bullock-drawn implements.

One example among several is the black, clayey soil of the Narbada Valley and adjoining regions. After the rains stop near the middle of September, 7 to 10 days are required for the soil to become dry enough to plough. Yet sowing must be completed by October 15.

The ploughing of this soil in such a short time means poor seed beds, wasteful high rates of seeding, and low yields. Tillage with heavy machines obviates these problems and leads to increases in yield of 50 per cent or more.

(3) For ploughing presently unused but potentially productive arable soil, including many village commons, which have been heavily overgrazed and trampled for years. The soils are so compact that little water soaks into them. Large areas of such potential cropland cannot be ploughed with bullocks but could be put into good shape with heavy tractor-drawn ploughs and harrows, along with appropriate additions of organic matter.

Many of these areas need tractor-drawn equipment only for the initial preparation; some may need it occasionally after that, or even annually if the soil is very clayey and especially if the time for preparation between crops, or between the monsoon and sowing, is short.

(4) Where heavy tractor-drawn ploughs are the only practical means for the initial preparation of some areas that are badly infested with tough, weedy grasses.

Recommendation 12: Special studies should be made of the need for tractor-drawn ploughs or other tillage implements, with a view to their procurement and use (1) where the soil areas will yield far greater increases in food production than is possible with other tillage implements, and where the cultivators have the ability, willingness, and organization to make effective use of the implements without significant subsidy beyond loans; (2) where neglected and compacted soils of derelict village commons can be brought into use, and (3) where new land development requires heavy initial ploughing or earth moving. Even scarce foreign exchange should be allocated for such machines where the benefits are very substantial.

5. EROSION CONTROL

Erosion control, as one aspect of soil and water conservation, is achieved mainly through water control and other practices for an efficient system of soil use. The use of bunds, terraces, small dams and other structures, diversions, masonry chutes, and the like is fairly well understood. All such structures must be kept in repair. In fact, a broken bund on an erosive soil is worse than no bund at all; the water is concentrated and a deep gully may form quickly.

These problems are especially serious on soils with relatively soft, yielding substrata. Once the gully eats through the more resistant subsoil, the material beneath undercuts; blocks of soil fall into a rapidly growing gully. Some landscapes in India are especially susceptible to this serious gullying. Badly located highway culverts, broken bunds, unprotected outlets of bunds, or any other cause of water concentration produces disastrous gullying. Subsequent restoration of the soil is exceedingly difficult and costly. Dramatic examples of severe recent gullying from these causes can be seen, among other places, on the potentially good red soils in the area around Bangalore.

Recommendation 13: Joint conferences among agriculturists and highway engineers should be held, in order to find ways to develop mutually satisfactory methods for joint planning for handling water in ways most helpful to soil stability and agricultural production.

Besides the need of erosion control for the onsite benefits to crop, grass or forest production, erosion control is needed in those catchment areas where the accumulation of erosion debris seriously shortens the life of water-storage reservoirs and similar works of improvement, both large and small.

The life span of some of the large reservoirs, such as that back of Bhakra Dam, can vary several fold according to the conservation work done to control erosion in the catchment area.

Recommendation 14: Suitable allotments for soil and water conservation works, including forest planting and protection from overgrazing, should be made within all plans for works of public improvement, such as water-storage reservoirs; and these improvements in the catchment area should be timed to begin as soon as firm decisions on the project are finalized and soil surveys can be made.

Similarly, small works need protection. The life and storage capacity of many tanks in areas of erosive soils are unnecessarily reduced by such erosion debris.

Recommendation 15 : Public assistance, through loans or subsidies should be given for constructing or repairing tanks, only where the designs provide (1) for as deep tanks as are practicable (considering the problem of sealing them against leakage by the use of special earth materials or chemical sealers) in order to conserve soil area and reduce evaporation, (2) *grass silt traps at the margins,* and (3) *proper bunds, diversions, spillways, and chutes to control erosion in the catchment area* so they may continue for a reasonable life span.

It is highly gratifying to learn that steps are being taken to develop appropriate laws and procedures for obtaining earth for making bricks without continuing the widespread destruction of highly productive soils through shallow excavations. These shallow diggings have already made many lakhs of acres of some of the most potentially, productive soil in the world unfit for any productive use except by very expensive earth moving and drainage. Measures are also needed to use narrower and deeper borrow pits along highway, railway, and main canal grades. These changes would save a large total area of good soils from destruction.

6. SOIL-BLOWING CONTROL

Soil blowing (or "wind erosion") is injuring many acres of potentially productive crop and pasture land through the removal of the surface soils from some fields and the formation of dunes in others. For large areas of food-producing sandy soils, this hazard is serious in the dry season on fallow or overgrazed land.

The problems of soil blowing are closely related to (1) soil cover, (2) the maintenance of a rough soil surface, and (3) windbreaks. The principles are well understood in India but the problem of uncontrolled grazing is basic to any significant control of soil blowing. Most of the active soil blowing can be controlled only by vegetation. With controlled grazing the amount of cover, both for browse or cutting and for soil protection, would be enormously increased; and it would be practical to establish windbreaks of tall grasses, trees, or shrubs at appropriate intervals to afford protection of sandy cropland. Active

dunes or blow-outs must be planted to appropriate species. But to be effective these also must be protected.

7. CONTROLLED GRAZING

The control of grazing is one of the most difficult and important agricultural and conservation problems in India for five principal reasons:

(a) With controlled grazing under systems that allow grass and browse plants to recover, the total yield of forage can be increased many fold. Simply amazing results testify to this point in many test areas within various parts of India.

(b) Overgrazing leads to the replacement of good species of pasture and browse plants with poor or even unpalatable species.

(c) Severe overgrazing leaves the soil bare and exposed directly to the sun, rain, and wind. Commonly a crust forms over the surface that further reduces water infiltration. Thus much of the water loss, soil erosion, and soil blowing are direct results of overgrazing.

(d) Great opportunities for commercial timber production, for fuel trees in the villages, and for useful windbreaks are unrealized because of uncontrolled grazing.

(e) Overgrazing reduces infiltration of water and consequently the water available for wells. In Rajasthan, for example, the extreme grazing of the steep stony hills reduces infiltration so much that wells are low yielding. With controlled grazing on these hills the increased crop production from the greater water supply for irrigation would greatly exceed the current forage production in the hills.

These serious problems have arisen for two main reasons: high animal numbers and uncontrolled grazing. By developing herds and flocks of high quality animals for production purposes, the numbers can be kept within bounds *and, at the same time, their productivity* greatly increased.*

Once vegetation is overgrazed, the surface soil tends to become crusted, compacted, and less permeable to water. The sprouting of new seeds is greatly impaired. All pasture grasses and browse plants require some periods of rest. During such time, food reserves are built up within their root systems. For some plants this rest period needs to come at certain seasons. Otherwise, they are so weakened that unpalatable species crowd them out or the soil remains bare.

In its barest essentials, controlled grazing consists *first* of relating livestock numbers at various seasons to the "carrying capacity" of the pasture, and *second*, of rotational grazing to allow for proper rest periods. (By carrying capacity is meant the total grazing that permits or encourages maximum forage production over a period of years. It cannot be determined by the best years since increases in animal numbers in such years leads to destructive grazing in other years.)

Controlled grazing also consists of an important *third* practice: the stopping of all direct grazing in order to have greatly increased production by hand or machine harvesting. On some soils, this alternative yields several-fold more forage than direct grazing. It is

* A fuller discussion of this point is given in a following chapter on livestock development.

especially important for strongly sloping areas of highly erodible soils and for dry sandy soils subject to soil blowing.

A *fourth* important practice is the accumulation of feed reserves in years of higher-than-normal rainfall in order to avoid heavy grazing and destruction of the vegetation in dry years.

Fifth, many grazing areas on strongly sloping soils are greatly benefited by contour furrowing, inexpensive contour bunds, and check dams to conserve the water for good growth. These practices also have been demonstrated in India.

Sixth, once arrangements for controlled rotational grazing are made, enormous further improvements may be had by reseeding pastures to proved superior strains of plants, together with some tillage and fertilizer use where needed for establishing good stands. Here too, excellent progress has been made during recent years in India at several stations, including the work of the Desert Afforestation and Soil Conservation Station in Rajasthan where the problem is especially acute and the potentialities very high.

With a proper combination of these practices, both forage production and fuel-tree production could be increased many fold.

Most people feel fencing is needed for such productive grazing management. In some places, local materials are available for fences; in many others materials are available for good posts of wood or stone. As local supplies of steel become available, substantial quantities of wire should be allocated to this very important need.

With a satisfactory educational programme and full understanding of the great benefits of controlled grazing by villagers and herdsmen, grazing *can* be controlled by proper herding with a minimum of fencing. This is done in several other countries.

The Team realizes that a comprehensive educational programme is needed to make planning of controlled grazing feasible and to have laws enforced. Yet the benefits are so very great that every effort should be made to achieve a balance in which grass, browse plants, and trees have a chance to make their enormous potential contribution to the nation's economy.

The progress of demonstrations in India of the great benefit from guarding vegetation and or other practices for improvement of pasture lands is highly gratifying.

Recommendation 16: Demonstrations of the great value of guarding vegetation, including grasses, shrubs, and trees, and of the other associated practices should be increased as rapidly as facilities permit, along with plant selections, seed multiplication, and reseeding of the desirable species of grasses, shrubs, and trees so that as many cultivators and herdsmen as possible can see the results.

Recommendation 17: In the light of the growing body of evidence, the Board of Agriculture of the ICAR should give this problem of grazing control a top priority for appropriate study and recommendations, working in full cooperation with leading experts in soil and water conservation, range management, farm management, and legal matters relating to rural lands. This kind of coordinated study should result in preparing and promulgating a widespread and intensive educational programme among cultivators and herdsmen and drafting of

model legislation for controlled grazing, including the licensing of grazing on all public lands under management systems that permit adequate protection of plants, soils, and water supplies.

8. FARM AND VILLAGE FORESTRY

Commendable beginnings have been made in farm forestry. Certainly the demonstrated skill in forestry for both timber and fuel production exists. But great unrealized opportunities are available for growing fuel trees, and trees for green manure on lands that are now essentially waste. Perhaps the greatest handicap to be overcome is the one of uncontrolled grazing, as just discussed. This problem can be handled by many village organizations themselves, however, once they realize the great benefits to be had. By fencing, in some places with local materials, or by proper herding, the young trees can be protected as easily as can growing crops.

In many villages, the timber, fuel, green manure, fodder from *controlled* lopping, and other tree products are nearly all net gain, since trees may be grown in areas of little potential for other productive use, along roadways, and in odd corners.

Farm forestry has a direct relation to soil and water conservation in several ways. With fuel trees, and an appropriate educational programme, wood may be substituted for cow dung, and thus dung made available to improve the soil.

Tree plantings on critical soil slopes reduce soil erosion and soil creep.

On many hilly areas, tree plantings reduce runoff and increase infiltration of water into deep substrata that maintain wells.

Considerable progress has been made in India on selection of forest species, varieties, and strains for large reserve plantings. Examples for use in agriculture include, among others, the improved ber, useful for its fruits, for fodder, and for fuel.

Recommendation 18: Forestry officers should give increased emphasis to farm and village forestry, to continued selection of species and varieties most adapted to such conditions, and to the breeding and propagation of superior strains of trees for local plantings.

9. CONSOLIDATION OF FRAGMENTED HOLDINGS

Prompt and effective land consolidation, in close cooperation with those responsible for soil and water conservation, offers one of the very best opportunities to increase food production and agricultural efficiency. A poor plan, however, not laid out in accord with the needs for field irrigation canals, drainage ditches, contour bunds, masonry terraces, and other needed works of improvement, leads to poor results that may even delay rather than promote the adoption of good farming systems.

The Team regards this matter as so vital to food production that it has been highlighted in an earlier section of this Report.

10. SHIFTING CULTIVATION

Shifting cultivation is practised in India in several places. For several lakhs of people it is a way of life for which alternatives satisfy-

ing to them are not at hand. It can be a good system; it can be a bad system. Technology can be applied to its improvement through modification and supplementation with mixed cultures of woody crop plants.

With increases in population, some areas under shifting cultivation are deteriorating seriously because of excessive shortening of the period under natural fallow and the encroachment into the fallows of poor species of shrubs and trees or, in extreme cases, of wild grasses that are annually burnt. The result is reduced fertility, excessive runoff, erosion, and reduced food production.

Where the deterioration has gone beyond the possibility of restoration, the only alternatives are supplemental industries, such as mining or cottage industries, or movement of the people to other areas.

But with some competent research, many opportunities are available for improvements in the system: (1) Some areas are well adapted to mixed cultures of woody crops and forest trees. Examples include palms, coffee, cashew, pepper, and the like. Several other possible crops should be explored. (2) Simple terracing can be helpful, and more elaborate terracing where there is an adequate natural water supply or where irrigation can be provided for valuable crops. (3) The most critical nutrient deficiencies can be corrected partly with small additions of mineral fertilizers to supplement the forest fallow, green manure, and compost.

This problem of improving methods of shifting cultivation is so urgent to the people involved, to large resource areas, to forest supplies, and to political and social stability in certain areas that the Team feels that action can be no longer delayed.

Recommendation 19: The Centre should develop an adequate research programme for testing likely possibilities for improving and supplementing the existing systems of shifting cultivation, and for developing new techniques, with full attention to the existing experience of local cultivators and to the results already achieved in Africa, especially by INEAC, Yangambi, Belgian Congo, in rationalization of such systems. Such researches should be closely associated with the Soil Survey programme and with programmes for demonstrations of the new crops and practices as rapidly as their soundness has been established.

11. RECLAMATION AND USE OF UNUSED LAND

Many hundreds of lakhs of acres of potentially good to excellent soil lie unused in India. Part is government land, part is common village land, and part is private land. In view of the urgent needs for both food and employment, such land should be used, either by its present owners or by lease, through the State, to qualified cultivators. Some States already have laws by which the State can compel private owners to lease such land at fair terms. All States should have such legislation. As pointed out in the *Tillage Practices* section of this chapter, some of these soils have been so overgrazed and compacted that at least the first ploughing may need to be done with tractor-drawn ploughs.

Recommendation 20: Adequate laws should be developed to provide that unused or very poorly used land well suited to crop pro-

duction be leased on fair terms to qualified cultivators for food production.

Some areas of potentially good land are being reclaimed for settlement. Such areas especially offer excellent opportunities for combined planning. In some cases, however, holdings have been plotted out without reference to soil conditions, to the extent that some holdings even include nothing but bare rock! Such bad layouts are very hard to adjust after the fact, but are easy to avoid in the planning stage before settlement begins.

Recommendation 21: The development of new land areas should be planned jointly with experts in soil and water conservation on the basis of adequate soil surveys, so that adequate layouts of holdings are ensured for efficient soil and water management and so that holdings have comparable potential for food production.

12. RISK INSURANCE FOR SOIL AND WATER CONSERVATION

Many cultivators hesitate to undertake well-proved combinations of practices because, with their very low incomes, they are afraid to take what is to them a serious risk. In fact, such fear of risk among cultivators is often wrongly called "conservatism." Good experience with appropriate guarantees against loss has already been had in Bombay State. Costs were negligible.

Recommendation 22: The Soil Conservation Board should work out reasonable ways to guarantee cultivators against loss from the adoption of radically changed systems of soil and water management that promise substantial increases in food production and income.

13. EDUCATION AND RESEARCH

Basically all new advances come through research and education. New ideas, the finding of new facts, and the fitting of these into practical systems are the very foundation of advancement, both now and in the future, in soil and water conservation.

Several phases of soil and water conservation do not now appear to be receiving adequate attention. A few examples follow:

(a) The whole array of problems relating to farm irrigation need attention. These include water conveyance within villages and to fields and farms; the control of seepage; the construction and maintenance of suitable structures; measurement of water; methods of application; amounts to apply for efficiency under different situations; and uniformity of distribution of water with different kinds of soil.

(b) Several problems of drainage are pressing for solution. These include the allowable heights of the water table in soils for various crops; systems for the removal of surface water and its contribution to waterlogging; methods for village and farm drainage where needed; the specific roles of open ditches and tiles and their spacing and depth under different conditions and the use of wells for drainage.

(c) Much needs to be learned and taught about the dynamics of soil behaviour as a basis for productive systems that reduce erosion to allowable limits and that develop and maintain good structure, high fertility, and the other qualities of good arable soils for various crops and cropping systems.

(d) A firm knowledge of the morphology and genesis of soils lies at the basis of the soil research and classification necessary for accurate soil maps that can be interpreted in terms of the responses of the soils to alternative systems of management.

Depending on their specialization, scientists conducting research on these problems should have training in mathematics, including the calculus, physics, chemistry, thermodynamics, hydraulics, plant physiology, geology, geomorphology, agronomy, and the several phases of soil science.

College Teaching

The Team should like to commend the Indian Agricultural Research Institute on the organization of a post-graduate school. Certainly this is a great forward step of far-reaching significance to Indian agriculture.

The Indian Institute of Technology at Kharagpur has a good agricultural engineering course for training conservation engineers.

Yet many agricultural colleges have not been able to meet the needed demands.

Special efforts are needed to strengthen the curricula and courses in both soil science and conservation engineering. Soil science is far more than agricultural chemistry and agronomy. Similarly, the training of conservation engineers needs to include more basic mathematics and science, including hydraulics and similar subjects necessary for thorough courses in irrigation methods, drainage, and such devices for water control as contour bunds, terraces, spillways, and the like.*

Recommendation 23: Appropriate steps should be taken by the Centre to work with agricultural and engineering colleges in order to help them develop satisfactory curricula for the potential soil scientists and conservation engineers so urgently needed in India.

Research

Already good beginnings have been made at several soil conservation research stations. Some of the major irrigation projects have agricultural research demonstration farms located in their areas to conduct research on crop varieties, water requirements, fertilizers, and cultural and management practices. These farms usually adapt research principles already known to local conditions and also serve as excellent demonstration centres. Such research and demonstration centres should be made available in most major irrigated areas as rapidly as trained scientists are available.

Two Additional Primary Research Stations

There is a need in India for more *basic* research in the field of soil and water conservation to help support and guide applied research. The urgent minimum needs in the near future can be grouped broadly under those for irrigated areas and non-irrigated areas. Two central research stations could be concentrated on each major set of problems. While these stations would be expected to conduct basic research of

* *See also*, Kellogg, Charles E., *Soil Conservation and Soil Survey in India*, 26 pp., Ministry of Food & Agriculture, 1959.

their own, the staff would recognize and use the research results in other countries of the world. Research findings from African and other tropical countries can be expected to be most readily adaptable to the tropical and sub-tropical conditions of India.

Thus these research stations would be concerned with studying and sifting all basic research findings relevant to soil and water conservation. Both the basic principles and the skills of research can more readily be transferred from one physical, biological, and social complex to another than can the applied techniques.

For example, the principle that contour bunds conserve water where there is run-off has application to nearly all non-irrigated lands. In some countries these may be constructed by large bulldozers, in others by bullocks, and in some by hand labour. How they are constructed is not scientifically important. But it is important that they *be* constructed and that their height and width and the slopes of the areas between the bunds be accurately determined in relation to the local conditions of soil, climate, and cropping systems.

The research station dealing with soil and water problems on irrigated soils should include research on the array of items already outlined including the design of water control, conveyance, and disposal structures; consumptive use of water by Indian crops; formulae of water movement through the soil; plant nutrient availability, absorption, and movement in plants in relation to soil conditions; and the other principles needed for productive and efficient soil and water conservation in India.

The research station for the non-irrigated soils would deal with some of the same basic theories, as applied to infiltration of water, increasing the rooting zone of soils, increasing water storage in the soil, reduction of evaporation losses from soil, methods of cultivation to reduce water and soil losses, and related problems.

The basic research as outlined need not be done at a large number of locations. Yet a system of cooperation and aid is needed so that as soon as a new principle is developed, it can be tested under varying conditions and practical designs can be developed for the various soil and climate conditions in the country.

Basic research has large requirements for both equipment and staff. Much of the expensive scientific equipment is needed at only a few locations. Many of the difficult soil and water conservation problems can best be solved by groups of highly trained scientists working together as teams. Such teams can work on problems originating over wide areas.

The two stations should be operated under the Centre, probably by the Central Conservation Board. The one concerned with irrigation and drainage should be located in the Gangetic Plain and the one concerned with non-irrigated soils located in the dryland of South India.

If suitable land and facilities can be found, it would be helpful to locate these stations with or very near other existing research stations, and more especially those connected with a good agricultural college. Some sharing of library and other facilities can be arranged; the advice of other specialists would be easily available; and the new work being done would be very useful as teaching demonstrations.

Funds must be available not only for adequate staffing of the

central laboratories but also for enough additional staff, so that one or two scientists attached to these laboratories may be located in each State. These men should be housed with State agricultural research workers where local applications of the principles found at the Centre laboratories are made. Such scientists of the Centre would work closely with the State research workers and endeavour to develop intimately cooperative programmes.

They would also cooperate with the Indian Council of Agricultural Research and their stations. They would, however, be under the administration of the two Centre laboratories. By such procedure the laboratories would be assured of facilities and personnel to conduct research on the broad national problems.

Recommendation 24: Two central research stations should be established to conduct basic research on national and regional soil and water conservation problems; one to be concerned with the irrigated areas and the other to deal with the non-irrigated areas. Funds should be available for close cooperation with the State agricultural departments and colleges.

Other Stations

On many experiment stations in India, attention is being given to the improvement of one or several crops. Most of these stations are neglecting the influence of several important practices of soil and water conservation, perhaps more especially water conveyance, use, and control. Knowledge could be obtained at these stations on the consumptive use of water by plants, what amounts of water are needed in irrigation, and so on. Only simple equipment is needed to log the soil water within the rooting zone as the crop grows and to measure the irrigation water applied.

A few other less complete experiment stations are urgently needed to deal with especially difficult soil problems. One example is a station devoted to the problems of shifting cultivation, as in Assam. (See Recommendation No. 19.)

Another is needed for the use of soils with laterite in South India. These soils present special problems for conservation and use. Once erosion has exposed the laterite layer and it has hardened, the soil is made permanently unsuited for plant growth. Kerala State makes wide use of such soils as well as of Latsols.

14. SOIL SURVEYS*

Commendable progress is being made with a standard soil survey to provide adequate interpretations for all programmes of soil and water conservation. It is hoped that continued support can be given this programme, now being developed jointly by the Centre and the States, to avoid the inevitable costly errors of attempting to carry out soil conservation measures without soil maps and the costly expedient of separate field surveys for each interpretation or use. Actually, in most areas, several interpretations are necessary. With an accurate standard soil survey, these can be made from the one map without the expense of remapping the same area for different purposes.

* *See also*, Kellogg, Charles E., *Soil Conservation and Soil Survey in India*, 26 pp., Ministry of Food & Agriculture, 1959.

Highest priority for soil surveys should be given to catchment areas above costly public works and to areas where plans are to be made for the consolidation of fragmented holdings; for reclamation and new land development; for soil and water conservation works, such as irrigation, drainage, bunding and the like; and for complex demonstration and extension work where cultivators are expected to make substantial changes in their practices.

As rapidly as possible, the results of experiments, including responses to fertilizer use and other soil and water conservation practices, should be summarized by recognized kinds of soil so that the results can be available for use by all technicians, and ultimately by the cultivators, dealing with each specific kind of soil.

Some additional effort is needed to develop specific working relations between the Centre and the State agencies responsible for soil surveys and to develop specific work plans for each soil survey project.

In some soil survey areas, additional data are needed besides the soil map itself in order that it may be effectively used and interpreted for the several specific purposes. *These additions should not be included as standard procedure everywhere,* but on a selective basis where the results are definitely useful. These include:

(a) Topography, as needed for bunding, irrigation, drainage, and land levelling, can be mapped as a part of the soil survey or concurrently with it, whichever is cheaper.

(b) Present land-use, as needed in a few areas. Where air photos are available, additional land-use data are not commonly needed.

(c) Cadastral lines among holdings should be shown on all detailed soil surveys so that cultivators, and those who work with them, can read the kind of soil of each holding clearly from the soil map.

Soil survey work is greatly expedited and the results are more accurate if good air photos are available. This is true even in areas where the detailed work is ultimately plotted on village plot maps. In rough forested areas or other areas with few roads, air photos are absolutely necessary for accurate work of dependable quality at anything like reasonable cost.

Recommendation 25: Every effort should be made to secure air photos for high-priority soil survey areas in advance of mapping.

15. ECONOMIC EVALUATION OF SOIL AND WATER CONSERVATION DEMONSTRATIONS

Demonstrations of alternative systems of soil and water conservation, along with other essential aspects of the farming enterprise, need to be evaluated in economic (farm management) terms, and especially in terms of simple farm budgets. Such evaluations are needed by the technicians, extension officers, and cultivators. With such evaluations, the many existing demonstrations will be more meaningful and the results more widely accepted and used by cultivators.

Recommendation 26 : Efforts should be made to have economic evaluations of demonstrations of fertilizer use, terracing, bunding, con-

trolled grazing, and other soil and water conservation practices in combination. **

16. TRAINING IN SOIL AND WATER CONSERVATION

Several special phases of training for workers in soil and water conservation need emphasis if the work urgently needed and projected for the Third Plan is to be carried out, in addition to items discussed under the sub-section on *Education* and *Research.*

In-service Training

Since few candidates are now adequately trained in soil science and conservation engineering:

Recommendation 27: Every opportunity should be taken to strengthen and to expand training facilities at Soil Conservation Research Stations and other centres for professional in-service training in soil and water conservation and consideration should be given to the establishment of 6-month training camps for diploma holders who can become local supervisors, under professional guidance, for expanded public works in soil and water conservation. (See chapter on *Public Works Programmes for Food Production* of this Report.)

Advanced Training

All candidates for assistance in graduate training or other advanced training should have demonstrated ability and willingness to work in the field where the soils are, ability to diagnose field problems, and ability to work *with* cultivators.

There is a tendency for experts in soil and water conservation to go abroad for study and observation in the United States, Western Europe, and other temperate countries. For certain special studies good opportunities exist. Yet for many phases of work with tropical soils, including shifting cultivation, mixed cultures with forest trees, soil classification and genesis, fertilization, and so on, some staff members would benefit by study tours in Central Africa and other tropical areas with good research and demonstration programmes.

Training of Agricultural Extension Officers and Block Officers

Although agricultural extension officers do not need to become experts in the highly technical phases of soil and water conservation work, they do need special training so they may:

(a) Promulgate those basic principles of soil and water conservation that can be widely adopted without special technical assistance or projects of works.

(b)) Recognize those problems that require technical assitance and help arrange for it from State or district technical staffs. (See Recommendation No. 29.)

(c) Prepare the way in villages for the development of soil and water conservation schemes, such as contour bunding, irrigation, drainage, and the like.

** For a full discussion of this subject see Part III, Chapter IV, above.

Library Facilities

A preponderance of the foreign books, pamphlets, and journals available to most soil scientists and soil conservationists in India have been developed in the United Kingdom, the United States, and other countries of temperate regions. It is important that graduate students and operating staff have available the literature in both English and French from African and other tropical countries, including the proceedings of symposia and conferences and special journals and reviews on tropical soil problems published in Western European countries. At least part of the staff should be encouraged to read the literature in French, especially that from the INEAC, Belgian Congo, from the Office for Scientific Research of the French Overseas Ministry, and from tropical countries in the French Union.

Recommendation 28: The Librarian of the I.C.A.R. should be asked to form a special study group to develop more nearly adequate lists of books and periodicals for the libraries used by students and field operating staff in soil and water conservation, with special reference to literature in both French and English from African and other tropical areas.

17. SOIL AND WATER CONSERVATION PROGRAMME PLANNING*

Although commendable progress is being made in some aspects of soil and water conservation in some States, the programme must be stepped up greatly if the food goals are to be met. Several technical aspects have been touched on in this report and are explained in greater detail in other reports. Emphasis should be given to a few general points:

Local Leadership

In carrying out special schemes and projects for soil and water conservation every effort should be made to develop local leadership and responsibility in the villages and larger units. Some officers charged with such projects, in India, have been highly successful along this line. Their examples should be widely followed. The work in catchment areas and villages should be developed *with* the people, not simply done *for* them. Few cultivators carry out plans they fail to understand or maintain contour bunds or other structures that they do not see the need of or do not regard as truly theirs.

The development of an understanding by the cultivators of the combined practices responsible for successful soil and water conservation may be a slow way, but it is the enduring way in a democratic society. And as the cultivator's understanding grows, he gains confidence that he can improve. Then he goes forward to new developments, increasingly on his own initiative.

General Education

Through the use of booklets, pamphlets, posters, and cinemas in the local languages, every cultivator should be made conscious of the great opportunities *for him* of soil and water conservation and of the

* See also Kellogg, Charles E., *op cit.*

need for 'bundles' or 'packages' of practices — the principle of combined practices—for him to realize the potential abundance in his soil.

Extension Education in Soil and Water Conservation

Extension officers in States, districts, and blocks have three important functions in soil and water conservation:

(a) Widespread extension, through demonstrations and other extension methods, of those principles of soil and water conservation that do not require works of technical design for application, including the use of fertilizers, composts, and green manures where soil moisture is adequate; the planting of fuel and green-manure shrubs and trees; the guarding of tree plantings and areas for grazing and for cutting forage; and so on.

(b) Recognition of the need for technical assistance on some fields for improving bunds, minor land levelling, conveyance structures, and the like, and arranging for such assistance from the district or State soil and water conservation staff.

(c) Preparation of the way for village schemes for soil and water conservation practices, such as developing new irrigation works or reorganizing old ones, contour bunding, drainage, and the like, either with or without the consolidation of fragmented holdings.

Staff for Technical Assistance

Besides specific project work on soil and water conservation, a staff of technicians should be available at the State or district offices for giving individual technical assistance to cultivators and small groups of cultivators on those items of improvement that do not require large works for significant results. Many cultivators need help for staking out lines for small contour bunds, for contour cultivation, and for land levelling. Other examples include improvements in water conveyance systems, guidance on tree planting, and the diagnosis of difficult problems of soil tilth and fertility. Technical assistance should be available for such problems where cultivators are prepared to go ahead also with the other practices needed for the work to be effective.

Recommendation 29: Each State should provide for a staff of technicians in soil and water conservation, not only for project work but also for direct technical assitance to cultivators and groups of cultivators as the need is identified by agricultural extension officers. Beginnings might be made at the State level but the Team suggests that such cadres should be available in district offices.

Preparation for the Third Plan

The general programme tentatively outlined for the Third Plan will require a greatly stepped up training programme to have qualified technicians for supervising and carrying out the work.

Every effort should be made now to strengthen the curricula and the course work in soil science and conservation engineering in the agricultural colleges of the country as outlined under the sub-sections on *Education and Research and Training* in this part of the report. Much can be done also by strengthening and expanding the training centres under the Soil Conservation Board.

After all, it would be wasteful of scarce public funds and would set the programme back rather than promote it if funds were spent more rapidly than qualified people may be trained for the work. Above all, soil and water conservation is effective only when all parts are properly fitted together in relation to the kind of soil being treated and to the cultivators who are operating the land.

Priorities for Grants

The Soil Conservation Board will need some additional staff to help in the preparation and evaluation of State schemes put forward for sanction and for inspection and evaluation of the technical adequacy of work in progress.

Every encouragement and full assistance for developing competent staff and adequate coordination should be given to the States by the Centre but priorities must take account of the ability of the State staffs to perform, as well as of urgency of need.

18. COORDINATION FOR SOIL AND WATER CONSERVATION

Since soil and water conservation touches directly or indirectly every other aspect of rural land and water use, coordination is always, in every country, a difficult problem that *must be solved* for successful results at reasonable cost. It would be neither wise nor appropriate to suggest some standard mechanism since conditions vary among the States. But appropriate high-level committees, representing all agencies dealing with land and water, are essential.

Recommendation 30: As the Centre implements its plan for inspection of all soil and water conservation work for which grants and loans are furnished, the extent and effectiveness of coordination among State departments of agriculture, forestry, irrigation, public works, revenue, and the like, should be a major consideration in the approval of schemes for soil and water conservation put forward for sanction.

CHAPTER VIII. CHEMICAL FERTILIZERS

The Urgent Need for Fertilizers

Great waste of funds and labour on irrigation and other agricultural supplies and practices is inevitable if fertilizer use is not increased. That is, *the anticipated and realizable benefits from large expenditures on irrigation, drainage, bunding, terracing, and improved seed will be largely lost without adequate use of fertilizers.*

Generally speaking, the soils of India, like other tropical soils, are too low in plant nutrients for satisfactory crop production without fertilization. The whole level is low, but especially in respect to nitrogen, phosphorus, and some of the trace elements. Many soils are also high fixers of added phosphorus. Fertilizers must be added, not only to correct these deficiencies but also to take advantage of the other growth factors, such as good soil structure, water, temperature, and sunshine. The use of fertilizers is not simply a means of increasing the yields of crops that would be grown anyway. More importantly, their use permits the cultivator to grow other kinds and varieties of crops which otherwise he could not grow at all, that are more nutritious, more valuable, and higher in potential yield.

Although the Team highly commends programmes to take full advantage of green manures (especially those from trees, shrubs, and other plants that do not compete with food crops for space and soil moisture), of animal manures and compost, and of wood ashes, it must be emphasized that such materials can substitute only to a small degree for the major part of the chemical fertilizers required for efficient production with high yields.

Further efforts to make fuller use of the potential supply of manures and compost should go ahead vigorously; but, based on past experience, progress is likely to be too slow to make any significant reduction in the requirements for chemicals during the next 7 years.

An excellent start has already been made in India along several lines: research, manufacture, soil-testing laboratories, integration with agronomic research, and general education. The great rewards in food production from further strong efforts along these lines should not be denied the people of India because of any lack of reasonably adequate fertilizer supplies.

Recommendation 1: If food goals are to be reached, fertilizers must have greater emphasis and a top priority in both agricultural planning and allocations of foreign exchange, both for fertilizer materials and for any machines needed for constructing new plants to produce high-analysis fertilizers within India.

Estimates of Third Plan Needs

The Ministry of Food and Agriculture has completed an excellent study of India's fertilizer needs through its Working Committee on Fertilizers. Its estimates are based on the results of numerous field experiments and of the soil-testing scheme.

The targets established call for gradual increases during the Second and Third Plans to an annual use in 1965-66 of 1,500,000 tons of nitrogen, 750,000 tons of phosphorus (as P_2O), and 200,000 tons of potassium (as K_2O).

We view these targets as *the very minima* if the food goals are to be reached. The amounts that could be used to advantage, and that it would pay cultivators to use with other good practices, would be of the order of 2 times the Committee's target for nitrogen, 4 times for phosphorus, and 7 times for potassium. We realize that the educational and supply problems of reaching higher targets than those the Working Committee has suggested may not be solved within the Third Plan. Yet strong efforts should be made to go as far as possible, especially for phosphorus and potassium. As the level of nitrogen increases from the use of chemical fertilizer and the hoped-for increases in composts and green manures, the relative need for phosphorus and potassium will increase.

One of the chief reasons for relatively low use of phosphatic fertilizers is their very high cost to Indian cultivators. This, in turn, results from the use of low-analysis superphosphate, which is very expensive to handle per pound of plant nutrient.

Some experiments are being started on the use of the trace elements. These experiments need to be emphasized so that the Working Committee can make similarly sound estimates for supply requirements of boron, zinc, manganese, and other trace nutrients.

Priority for Distribution of Scarce Fertilizers

The Team received the impression that an undue proportion of the scarce fertilizers went last year to non-food crops, and to sugarcane. As one example, cultivators growing coconuts lacked potash while many growers of non-food crops seemed to have abundant supplies.

Perhaps a more orderly approach toward reasonable and fair allocations can be suggested from the Centre as a basis for discussion with the States, by taking full account, country-wide, of the soil requirements, the crops being grown, the opportunities for increased food production, the minimum requirements of non-food and export crops, and the extent to which districts are carrying out the other practices necessary for the fertilizer to be effective.

With State allocations established, allocations within States should be made on a similar basis.

Recommendation 2: For as long as fertilizers are in short supply they should be allocated primarily to growers of food crops, mainly according to (1) the opportunities for increased food production and (2) the extent to which cultivators are using the other practices necessary for fertilizer to be most effective.

Determining Requirements for a Balanced Supply of Plant Nutrients

A balanced fertilizer can only be had for a particular situation or a group of *like* situations. Attempts at so-called balanced fertilizers for a crop over a wide area having different soils lead to costly waste. That is, the requirement for any field is met by the needed kinds and amounts of fertilizer materials supplied to the arable soil at the right time for the crops to be grown. Any amounts used beyond this are largely wasted.

Wrong interpretations of evidence from the occasional use of very unbalanced fertilizer practices have occasionally led some people to conclude that fertilizers somehow injure the soil. In extreme cases very high rates of nitrogen, as chemical fertilizer or as manure alone,

without the other necessary nutrients can lead to lodging and greater susceptibility to disease. Such examples are rare. Nor can fertilizer alone make up for poor seed beds, bad water management, ill-adapted crop varieties, untimely sowing, nematode infections, and the like. But the evidence is abundant that because of the greater root systems and other residues left by high-yielding crops, well-fertilized soils accumulate more organic matter, not less, than unfertilized soils.

Rather than injuring soils, the great increases in soil productivity in recent years in other countries could not have happened without chemical fertilizers. More nutritious kinds of food crops are grown on fertilized soils. And all other farm practices have had a chance to make greater contributions because of the more fertile soils. Yet despite the great progress made, the future possibilities are even larger still, especially in warm long-season areas with good supplies of water as in many parts of India.

The requirements for amounts and kinds of fertlizers depend upon several factors in combination including:

(a) The Kind of Soil

Of the arable soils of India that respond to nitrogen (and this includes practically all of them having reasonably adequate supplies of moisture), about one-half also respond to phosphorus, and about one-fifth to potassium. Several kinds of soil respond also to magnesium, iron, zinc, boron, manganese, molybdenum, and perhaps others, either alone or in combination. Some of the trace-elements can be applied most effectively by first mixing them with other materials to be applied; others can be added best as sprays, say of iron on pineapples; and of zinc, or iron and zinc together, on citrus. As the level of husbandry improves with the use of larger amounts of the primary nutrients, the need will increase to correct deficiencies of the trace elements in order to have a *balanced* supply of nutrients at the most economic level.

(b) Past Soil Management

Adjoining fields of the same kind of soil can vary widely in current fertilizer requirements because of differences in the residual effects of cropping systems and of long-continued use of phosphatic fertilizers, farm-yard manure, and other materials. This variation is especially important, too, in estimating the amounts of phosphatic fertilizers to use. The effect of these fertilizers extend well beyond the first crop to receive an application. Then too, areas that have been improperly tilled may give lower responses than normal because of bad soil tilth. Similarly, areas that have been allowed to erode or to become waterlogged or salty give low responses.

It is very important to remember that the basic responsiveness of a kind of soil (as identified in any sound scheme of soil classification) is substantially a constant; but differences in past management can cause different areas of the same basic soil type to vary in their year-to-year fertilizer requirements.

(c) Water Supply

Here again, fields with similar soil but different water supply have different fertilizer requirements. Generally in dryland areas, sloping soils without contour bunds give small or even no increases in yields when fertilizer is applied. With accurately laid out contour

bunds (in contrast to simple field bunds), however, similar soils may give large responses.

Evidence in India shows that the total annual rainfall is no guide to where fertilizers are effective. *The important factor is the amount of water in the soil when the crop needs it.* A large part of the rain falling on unbunded cultivated sloping soils of low permeability runs off and is lost to the soil, especially if the rain comes with high intensity during short periods. Other soils with permeable surface soils, and retentive but slowly permeable subsoils, give good responses to fertilizers, if properly bunded, where the rainfall is only 20 inches or even less.

Similarly the fact of irrigation alone is not a firm guide to the total amount of fertilizer required for efficient production. Under good irrigation *without waterlogging*, very large increases can be expected. In fact, on nearly all of the soils of India *costs of irrigation cannot be repaid without substantial fertilization for high yields.*

(d) Crops to be Grown

First of all, if the crops grown are ill-adapted to the soil—either because of restricted root systems, unsuitable climate or other unfavourable factors—fertilizers will give low responses. Moreover, some varieties of some crops give low yields even on fertile soils. One of the objectives in plant breeding is to develop varieties that will give high yields *with* improved soil fertility. The disease-resistant factor of improved crop variations may lead to yield increases over diseased crops, even without fertilizer. Yet varieties of paddy, wheat, maize, jowar, and other crops with other potentials for high yields rarely give economic increases without fertilizer use.* India already has good examples of improved crops that are no better in yield than the old varieties *without* fertilizer, but that are very much higher in yield *with* fertilizer.

(e) Plant Protection

Diseased plants or those unprotected from destructive insects and animals show little response to fertilizers, in terms of yield. Where such depredations are uncontrolled it is wasteful to use fertilizers.

Basis for Fertilizer Recommendations to Cultivators

India has made an excellent start toward a sound programme of laboratory soil-testing and demonstration. This programme needs further emphasis along several lines. First of all, much benefit can come from careful integration of the field experiments and soil testing with the soil survey programme. Similar soils have similar basic potentials for response. Different groups of soils require different laboratory methods. Interpretations of the same test, in terms of amounts to be recommended for application, vary with the kind of soil tested.

Test results from surface soils alone are hardly enough for reliable recommendations. Many plants feed deeply in the subsoil and their growth responses depend upon the physical condition and

* This fact is not clearly revealed in sample yields from cultivators' fields since cultivators who use improved seed are likely to use also several other better practices that raise yields.

water supply of the deep as well as the surface soil. Some idea must be had of these other soil conditions, in order to make good recommendations in which the cultivator can have continued confidence.

The following items need to be integrated with the Soil Survey and given emphasis:

(a) LABORATORY TESTS

Continued emphasis is needed upon accurate laboratory work on well-collected soil samples that are accompanied by adequate notes on other soil features, cropping, history, and the like.

No funds should be wasted on quick field testing with field kits by any personnel other than well-experienced experts. Few such field-testing kits give reliable results even in the hands of experts.

Plant deficiency symptoms are also useful indicators to the expert. But often two or more occur together and some symptoms are compounded with damage by disease, insects and nematodes, so that their meaning cannot always be read accurately.

(b) STANDARDIZING LABORATORY SOIL TESTS WITH FIELD EXPERIMENTS

Further field experiments on *representative areas of the important kinds of soil* are needed to improve standardization of laboratory tests so that most accurate recommendations can be given according to the kind of soil the cultivator is using.

(c) FOLLOW-THROUGH WITH CULTIVATORS

More follow-through is needed during and after laboratory test results and recommendations are given to a cultivator. This is necessary in order to clear up any misunderstandings, to help him learn how to apply materials, to suggest the needed practices that will make the fertilizers most effective, and to check on his results in order to improve future interpretations and recommendations.

(d) WIDE NETWORK OF DEMONSTRATIONS

Much of the recent progress in fertilizer use in India has come about by the judicious use of free fertilizer demonstrations by extension officers. This programme should be continued in areas where cultivators are now using little or no fertilizer even though it would be profitable for them to do so.

Demonstrations should be arranged so that each cultivator can see the *main opportunities* for fertilizer use available to him *within farming systems that he can achieve.*

(e) ECONOMIC ESTIMATES OF COSTS AND BENEFITS

To make demonstrations effective, estimates of net economic returns are needed along with the physical demonstrations of fertilizer use and other practices. Nearly all cultivators must be convinced that fertilizers more than pay. A physical demonstration is usually convincing only if accompanied by economic analysis.

(f) WIDER COOPERATION IN SOIL-TESTING SCHEME

All soil research stations should participate in the soil-testing scheme according to a definite, written plan of cooperation. In any undertaking for soil and water conservation research, demonstration, or project development, fertilizer use is usually a critical factor. Soil

Conservation Stations must deal adequately with all relevant factors of soil fertility.

Where fertilizers are essential to the success of a soil and water conservation demonstration, they should be provided for in the budget allotments for the demonstration. Similarly, where fertilizers are essential to a project scheme, and the cultivators have not been using them significantly in the past, the initial cost of the fertilizers, say for 1 to 3 years, should likewise be included in the budget allotment.

Recommendation 3: Added emphasis should be given to (1) the standardization of laboratory soil tests with field experiments on the important kinds of soil; (2) coordination of the soil-testing scheme with the Soil Survey; (3) follow-through by field officers of test results; (4) full recognition of other factors besides test results of surface soils that influence recommendations; (5) a wider network of village demonstrations; (6) free 3-year demonstrations, in areas where fertilizers would produce large increases, for cultivators who will also use other pratices to make fertilizer effective; (7) estimates of economic returns along with physical demonstrations of the results of fertilizer use; and (8) developing definite cooperative relationships in the soil testing scheme with the Soil Conservation Research Stations and all other experimental stations doing research on or conducting demonstrations with soils or crops.

Advantages and Limitations of Mixed Fertilizers

For intensive farming, where 2 or more nutrients are needed at the same time, it is convenient to use *a mixed fertilizer.* (Sometimes a mixed fertilizer is called, incorrectly, a "complete" or a "balanced" fertilizer. A fertilizer cannot be called either "complete" or "balanced" unless accurate laboratory soil tests indicate, *and* accurate field trials prove, that *after its reaction* in the soil, the arable soil has the optimum amounts of *all* plant nutrients.)

Where 3 nutrients—say nitrogen, phosphorus, and potassium—are required, a mixed fertilizer saves 2 operations since all can be applied at one time. For example, maize or cotton may be given a mixed fertilizer at planting time, and supplemental nitrogen alone at a later time. Then too, one of the primary nutrients, or some trace element, may be needed in so small an amount that it would be difficult to apply it evenly by itself.

Commonly it is more convenient to mix the materials properly at a fertilizer mixing plant than at home.

On the other hand, the requirements of individual fields vary so widely in the relative amounts needed that unless several standard mixtures are available, some fields will get too little of some nutrients to be effective and too much of others, which is wasteful.

There is great danger that mixed fertilizer will be of low analysis, and hence costly to transport. This can be avoided in part by shipping only the "straight goods" of high-analysis and mixing them at local plants.

Canal sludge, oil cake, and other materials low in available plant nutrients should not be added to mixtures, except where a conditioner may be required in mixed fertilizers of high analysis.

The fertilizer vendors for reasons of profits may push mixed fertilizers and withhold the straight goods from the market. Where

this is true, the cultivator needing only one nutrient cannot easily obtain it except by buying the more expensive mixed fertilizer that he may not need.

Research and Promotion of High-Analysis Fertilizer Materials

Unhappily, traditions have developed in India favouring ammonium sulphate and ordinary superphosphate. Both are materials of low analysis and consequently very costly for freight, bagging, and handling per pound of plant nutrients.

This is a serious handicap to Indian cultivators, and consequently to attaining the food goals. It is often argued that it is as cheap, or even cheaper, at the manufacturing plant, per pound of P_2O to make low-analysis superphosphate, than to make high-analysis phosphatic fertilizers. But this is not the relevant point.

The question is *the cost on the cultivator's field*. It take 3 times the bags, 3 times the freight, 3 times the storage, and 3 times the handling for a 16-per cent material as it does for a 48-per cent material. These costs far overshadow small differences in manufacturing costs per pound of plant nutrient.

Then too, in the case of phosphatic fertilizer, analyses in India, as in some other countries, are given as P_2O_5 not in terms of P (phosphorus) as they should be. This fact gives a highly exaggerated concept of the amount of plant nutrients present. Actually 16-per cent superphosphate contains only about 7 per cent phosphorus.

We realize that traditional low-analysis fertilizers are best known and that materials of higher analysis will need some research testing and demonstration under Indian conditions. Already satisfactory experience has been had with urea and with ammonium phosphate. The manufacture and use of urea should be pushed heavily because of the great savings in transport. A satisfactory and cheaper alternative to bonemeal is also needed.

Many kinds of high-analysis materials are already in wide use in several countries and have proved themselves in tropical agriculture. Certainly sufficient quantities of these could be imported at once for wide research testing. Problems of rates, placement, equipment, and the like can be rather quickly worked out for those high analysis materials already in wide use in other countries, but which have not yet come to India, such as calcium metaphosphate, ammonium metaphosphate, double superphosphate, urea, and the like.

India has a rapidly growing corps of skilled physicists and chemists well able to modify and redevelop plans for chemical industries to manufacture satisfactory forms of fertilizers of high analysis. This research should get under way at once.

Industries now manufacturing materials of low analysis, say less than 30 per cent nitrogen or 35 per cent phosphoric acid, need not be alarmed. Demand for all fertilizers will be so high that their output can be readily used. Opposition by present vendors of low-analysis materials, should not be allowed to delay the realization of the big opportunities for higher food production possible through cheaper high-analysis fertilizers to the cultivators.

Recommendation 4: Emphasis should be given to fertilizers of high analysis because of the excessive costs for freight and handling now being paid by cultivators. Immediate plans should be developed

for (a) research-testing of high-analysis materials, (b) importation of such materials for test-demonstration on important soils and crops, (c) large-scale importation for general field use as soon as possible, and (d) industrial research for manufacture of such materials within India.

India needs a strong staff, mainly of industrial chemists and engineers, in the field of fertilizer technology in addition to the continued field experiments and soil testing.

Such a staff should have the following principal functions:

(a) Obtaining fertilizers of high-analysis already proved in other countries and arrange for their field testing and demonstration on Indian soils through existing agencies. This staff would not itself engage in agronomic research but would cooperate closely with those conducting fertilizer experiments and field trials and demonstrations.

(b) Carrying on any necessary laboratory or pilot-plant research and testing of new materials, including:

- (i) Improvement or testing of manufacturing processes with the most economically available materials and sources of power. (The emphasis should first be on promising high-analysis fertilizers already being manufactured in other countries; and later attention can be given to the development of entirely new fertilizers.)
- (ii) Improvement or development of methods for granulating fertilizers.
- (iii) Development of the best methods for formulating and mixing fertilizers for most economical use by cultivators under Indian conditions with the most economically available materials.
- (iv) Development of suitable methods for protecting fertilizers from damage during storage and transport.

(c) Collecting and maintaining current statistics on the supply, use, and both wholesale and retail prices of fertilizers in India; also on prices in other countries of those fertilizers and the necessary raw materials India imports.

(d) Collecting and maintaining up-to-date information on techniques, including designs of equipment, for the manufacture, processing, and shipment of fertilizers that are or may become important in India.

(e) Advising the Minister of Food and Agriculture and other high officials on the technology, supply, transport, marketing, import, availability, pricing, and manufacturing of fertilizer.

Recommendation 5: Early consideration should be given to the organization of an all-India Centre of fertilizer technonolgy within the Ministry of Food and Agriculture to deal with the pressing problems of fertilizer development, manufacture, import, supply, transport, and related problems.

Opportunities for Increasing the Efficiency of Fertilizer Use

Combined Practices

As with all other soil and water conservation practices, fertilizer use is most efficient when combined with other practices necessary for

developing a good arable soil; good water management; the use of green manures, farmyard manures and compost; plant protection; superior seeds; and so on. As indicated elsewhere in this report, ways must be found to overcome the widespread tendency toward single-practice extension work in India. It may be more difficult to show a good complex demonstration in which two or more practices are combined, but the advantages are greater than the difficulty.

Fertilizer to Fit the Local Situation

Broad generalized recommendations of kinds and amounts of fertilizers for a large area can lead to waste. Recommendations can and should be tailored to the local kind of soil, past management, crops to be grown, water supply, and so on, as partially guided by laboratory tests.

Localized Applications

With many crop plants grown in rows or in hills, fertilizer is most effective if localized near the seed. For many crops a good placement is about 1½ inches below and 1½ inches to the side of the seed. Generally, the more soluble the fertilizer material is in water, the more likely it is to "burn" the seed if placed with it or near it. Also some seeds are more sensitive than others. Thus proper placement recommendations, for local use, must accompany all extension teaching and demonstrations.

Although good results have been had in India and elsewhere with the proper placing of nitrogen-carriers and other fertilizers, localized placement, or getting the fertilizer near the seed, is especially important with phosphatic fertilizers. The highly weathered tropical soils, especially the red and yellow varieties, are commonly high fixers of added phosphorus. By localized placement, in contrast to broadcasting, the phosphatic fertilizer comes in direct contact with much less soil, less of the phosphorus is fixed, and more is available to the crop.

Simple ways of fertilizer placement, by hand or by simple machines, can be adapted from other countries or developed through research in India.

Split Applications

Highly soluble fertilizers should usually be applied to crops in 2 or even 3 applications. If the total recommended amount of nitrogen is put on maize at seeding time, for example, much of it will probably be leached away from the upper root system before the crop gets it. Maize needs nitrogen for a good start, but its greatest bulk need comes later when it has made about one-third of its height growth. A second application should be made at this time. Split applications of potash are best for crops such as lucerne (alfalfa) that are very heavy users of potash. Where large amounts are needed and applied all at one time, these plants feed excessively and wastefully on it. This is sometimes called luxury consumption. To avoid it, the total potash application should be split into 2 or 3 applications for best results.

With most annual crops on most soils it does not pay to split the phosphorus application. Detailed suggestions, based on research results in India and elsewhere, need to be summarized for cultivators locally in terms of the materials available and the crops being grown.

Other Opportunities Should be Looked for

Liquid manure and sometimes other soluble materials can be added with irrigation water in well-controlled irrigation systems.

As techniques advance, there will be opportunities in the distant future within India, on large fields of level stone-free soils, for the direct application of anhydrous ammonia, which is much cheaper per pound of nitrogen than the solid form.

For intensive culture under highly skilled management, nitrogen and other primary nutrients as well as the trace elements, can be added in sprays.

Lime is needed on the acid soils, especially those of the northern highlands. Gypsum is needed for the improvement of alkali soils. Both of these materials are bulky and freight costs are so high in places as to discourage their use. Some States have arranged for concessions on freight charges. Studies should be made with the railway officials of appropriate ways to give low rates for agricultural lime and gypsum where their use is critical to increased food production.

Recommendation 6: Each State should have a well-trained, experienced senior officer, with a small staff, to coordinate the fertilizer programme of the State under the Director of Agriculture. This officer should be a soil scientist well trained in chemistry and agronomy, or an agricultural chemist with field experience in soil science and agronomy.

CHAPTER IX. IMPROVEMENTS IN CEREAL PRODUCTION, INCLUDING PLANT PROTECTION

The total cereal production in the country has increased during the last 10 years from 48.4 million tons (1949-50) to 52.8 million tons (1957-58). Much of this increase has been due to an increase in acreage rather than an increase in yields per acre.

Rice and wheat are the two major commodities, with a production of 32.5 million tons or about 62% of the total cereal production. Rice is very much more important than wheat and their total production is roughly in the proportion of 3.5 to 1. Other cereals, including millets, jowar and maize yield about 20 million tons, or about 38% of the total cereal production. In addition, various pulses contribute about 9 million tons to the food supply. (All 1957-58 figures.)

ANALYSIS OF PRODUCTION POTENTIALS

The real criterion for increased production should be based on the trend in the acre yields and not on total production. An examination of the data would indicate a 10% increase in acre yields of rice or roughly a 2% annual increase over the pre-plan period. This increase, however, has come about by an increase in acre yields of about 16 to 17 per cent in the two states of Madras and Andhra Pradesh, about 7 to 9 per cent in the yields of Mysore, West Bengal and Madhya Pradesh. There has been no perceptible improvement in the acre yields in other so-called "problem" states such as eastern Uttar Pradesh, Bihar, Assam and Orissa which have not recorded any change in acre yields.

An examination of the total rice production in the country shows that nearly one-fourth of the total production comes from 25 districts of India. Thus, the immediate potential for production increase would appear to lie in these areas which have shown a marked improvement in acre yields. It is in the southern states of Madras and Andhra Pradesh that comparatively larger areas under rice crop have irrigation facilities. Rice research has been in progress here for a longer time and good improved varieties of paddy are available. Farmers are also anxious to utilize all technological knowledge in the growing of the crop. Similar, though smaller, areas also exist in other states.

If the target of 110 million tons of food-grain by the end of the Third Plan period is to be achieved, the present rate of improvement of acre yields cannot be depended upon and there should be a considerable intensification of technological improvement in growing the crop. Sufficient technological knowledge is available for stepping up production but to bring about immediate and rapid increase in production so that the target can be reached, this improvement will have to be concentrated in areas where the application of technological methods can result in the greatest benefit.

This would mean that there should be a concentration of effort, particularly in irrigated areas where the growing of good seed, application of fertilizers, good cultivation practices, use of insecticides, etc., can achieve the greatest benefit. Experience available in Bombay State has shown that where intensification of technological improvements

is combined with the necessary facilities to the farmers, appreciable increases in production can be obtained. If approximately 10 million acres of rice in the selected areas were provided with the necessary facilities such as fertilizer (30 lbs. nitrogen and 30 lbs. phosphoric acid per acre), improved seed, pesticides, irrigation, improved cultural practices, etc., it is estimated that an increase of about 2.5 million tons could be obtained.

In terms of fertilizer requirements (ammonium sulphate and 18 per cent superphosphate), this would require about 6.5 and 7.2 lakh tons respectively. Obviously, this goal cannot be reached unless much greater emphasis is given to chemical fertilizer in the production programme. It is interesting to note that only about 40-50 per cent of the limited fertilizer supply in the country is used for cereal crops.

Priority for immediate emphasis on selected districts does not mean that other districts should be neglected. Production increases in these other districts would be gradual and should be greatly intensified as technical personnel and production facilities are made available.

With regard to the "problem" areas of rice production, the main causes of the present low yields are: poor fertility of the soil, erratic rainfall, lack of adequate water supply, floods and poor drainage, cultivation of unsuitable varieties, etc. Improvement of all these conditions will be a long-range problem. They should receive special attention and would need investigations and plans for improving the position by a coordinated effort of different specialists.

What has just been said with regard to rice can apply equally to wheat. The greatest opportunities of increasing production of wheat would appear to exist in Punjab, parts of Uttar Pradesh, Madhya Pradesh and Bihar.

CEREAL PRODUCTION

Methods for obtaining increased yields for cereal crops are principally the same throughout the world and are based on the following essentials: (1) improved varieties, (2) high soil fertility levels and efficient fertilizer utilization, (3) plant protection, (4) proper cultural practices including rotation and weed control, (5) mechanization, and (6) adequate research personnel and facilities. Other essential elements for increasing crop production such as irrigation and drainage and soil conservation are discussed in other sections of this report.

Plant Breeding

The Government of India has for a number of years supported an active plant breeding research programme. Major emphasis has appropriately been directed toward the principal food-grain crops. Plant breeders report that India's vast size and extremely wide range of soil and climatic conditions and diversity of crops present numerous difficult problems to the plant breeder. Rice varieties, for example, are required for a multitude of varying conditions of elevation, sowing season, flooding, drought, salinity, disease, etc. This situation tends to dilute the plant-breeding effort since it is not possible to concentrate on varieties that cover vast areas. Similar problems in plant breeding exist for most of the important crops.

Under the conditions of the available funds and facilities, the plant breeders of India through dedicated effort have successfully evolved new varieties which represent substantial improvement. However, the magnitude of the breeding work has not been sufficient to supply the improved varieties needed for the diversity of soil and climatic conditions existing in India.

Rice: A number of rice-breeding projects are in progress and the following must be intensified:

1. BREEDING FOR STRONG STRAW: Most of the varieties now grown in India have weak straw and efficient response to fertilizer is not always obtained. Sound progress has been made with the Indica-Japonica crosses towards the development of hybrids with strong straw and high response to fertility. The production of highly promising results by the Indica-Japonica hybridization project can be usefully extended to other programmes for different objectives. Known types, possessing the desirable features to be introduced in the Indian varieties, can be obtained from the stock of genetic types maintained at the Cuttack Institute. These can be used as common parents in the programmes, while the best of the local varieties can be picked out from the improved varieties existing in the States to form the other parents. Several such coordinated and cooperative projects were discussed at a recent meeting of rice research workers and must be put into immediate effect. It is only by such cooperative projects that the maximum use can be made of the limited technical personnel available in the country.

2. BREEDING FOR EARLY MATURATION PERIOD: There is need for better high-yielding varieties with a maturation period of about 100 to 120 days. Such types are necessary because they can be grown any time of the year (varieties can be developed that are non-sensitive to photoperiod); they can be grown in areas where the water supply is limited to shorter periods, and less water is required for these types than for the 160-170-day maturity types.

The belief in certain quarters that the longer the maturation period the greater the yield is not necessarily true. It has been demonstrated in India and other countries that high-yielding varieties of both short and medium maturation types can be produced. Also, in certain limited areas in India such as Andhra Pradesh, Mysore, Kerala and Madras, where rice is double cropped, one or both of the rice varieties should be of the short maturation type.

3. BREEDING FOR NON-SENSITIVITY TO PHOTOPERIOD: Most varieties grown in India in the long maturation group are photosensitive. Thus, if planting is delayed because of the shortage of water, the vegetative period of the variety is shortened and yields are reduced. Therefore, it is important to produce non-sensitive, late maturing varieties.

4. BREEDING FOR RESISTANCE TO DISEASES AND INSECTS: The use of resistant varieties is the most economical means of disease and insect control. Apparently more work has been done on breeding for disease resistance than breeding for insect resistance. The two most important diseases are *Piricularia oryzae* and *Helminthosporium oryzae*. Piricularia may be very destructive especially in Southern India, and every effort should be made to incorporate tolerance to the disease in

new varieties. It should be noted that Piricularia will very probably become more severe as the use of nitrogenous fertilizer is intensified.

Breeding of blast-resistant varieties has been successfully followed in Madras State and similar work is also in progress in Bombay and Andhra Pradesh. Suitable techniques for determining resistance to blast have been developed at the Central Rice Institute at Cuttack. It is time that a fully coordinated programme of breeding for blast-resistance is undertaken in all the states of the Southern region. Such an approach would require special facilities to be provided at one or more centres for testing the plant material for blast. Lack of such facilities will slow down the breeding programmes.

The available information at Rice Institute, Cuttack, and in West Bengal about an equally important disease of the north-east region, i.e. *Helminthosporium*, can be utilized to draw up a coordinated programme for breeding for Helminthosporium resistance in that region.

Insect pests of rice are controlled primarily by the use of insecticides. However, it should be noted that rice varieties exhibit a considerable degree of variability with regard to stemborer, leaf hopper, and gall fly incidence. The work in progress in India on the testing of varieties and genetic stock for resistance to major rice pests appears promising and entomologists should play a more important role in rice breeding programmes.

5. Breeding for Unfavourable Conditions: Breeding for resistance to salinity, akalinity and drought should be intensified. Plant physiologists and breeders should cooperate on any proposed schemes, since fundamental work is needed before adequate breeding programmes can be established. It should be noted that only about 35 per cent of rice acreage in India is irrigated and ample water is not always available for rice in many of the non-irrigated areas.

Rice breeding work has been in progress in most rice-growing States and outstanding results have been obtained particularly in Madras, Andhra Pradesh and some other States. The Central Rice Research Institute which has been set up by the Central Government to deal with all fundamental aspects of rice research also deals with rice breeding and coordinates research activities in the country.

Because of the lack of trained personnel, facilities, and sufficient recognition of the importance of close cooperation between the States and the States and the Centre, the magnitude of the rice breeding work has not been sufficient to supply the varieties to fit the various needs for Indian rice culture. At the present time, in view of the lack of trained personnel and facilities, it is felt that more progress could be made if the existing personnel and facilities were concentrated at a few centres in important rice growing States.

Because of varying climatic and soil conditions the need for certain regional stations is recognized. In States where Central stations have been established, the regional stations should be fully coordinated with and under the technical control of the Central station. It is also necessary that the Central stations in the States should be located, insofar as possible, in the same place as the State college and research institute so that the breeding work will be done in full cooperation with plant pathologists, entomologists, agronomists, geneticists, and plant physiologists.

Wheat: Adapted high-yielding varieties resistant to the prevalent races of rust have been developed. Rust is a serious threat to sustained high wheat yields and the dependability of food supply is greatly enhanced by the improved varieties having varying degrees of rust resistance. The duel between the plant breeder and new races of rust is, however, continuous. At present it would appear that certain large wheat-growing areas are potentially subject to severe loss, should a rust epidemic occur. For example, C 591 was found as a dominant variety over large areas of several states. This variety was developed many years ago and does not possess the degree of built-in rust resistance of some newer varieties. A rust epidemic would be devastating to food supply. Thus it would appear that efforts should be made to reduce the acreage devoted to C 591 and similar susceptible varieties. We recognize that C 591 is an "old" variety often alleged by extension workers to be superior in yield over wide areas. Experience in the U.S. proves that improved wheat and other cereals varieties tend to have a useful life span of 10 years or less and are being replaced periodically with new even higher yielding disease resistant varieties.

Breeding for rust resistance in wheat has been in progress in Delhi for several years and work is also coordinated for othr regions, with 4 sub-stations established in the regions under the control of Pusa Institute at Delhi. Facilities have been provided to test the material for rust resistance under controlled conditions. There are also other wheat breeding schemes in progress in the different States: Punjab, U.P., Bihar, Rajasthan, Bombay and Madhya Pradesh.

There is considerable scope for intensification of wheat breeding work at the Centre as well as in the States. More facilities are needed for testing additional samples for new races in order that the plant breeders can make the required crosses for resistance. Introduction of new rust resistant varieties to replace susceptible varieties appears to be very slow, and the race problem may have changed by the time the variety is grown on a wide scale. The relatively small number of races reported may be due to inadequate sampling.

Although plant breeding work is very important and rusts are the most important diseases on wheat, it should not be overlooked that there is need for increased emphasis in research in other fields such as agronomy, entomology, plant physiology, etc.

Also, breeding work should cover a wide range of disease on wheat. Relatively unimportant diseases may become major diseases when new varieties are adopted and some of the value of breeding for disease resistance may be lost if emphasis in the breeding work is placed on too few diseases. The research personnel we have contacted are well aware of the problems and need for additional research on various phases of cereal production.

Millets: Millets (with sorghum) represent an important group of food plant crops which have to date received only minor attention from the plant breeder. Very recently, however, a coordinated hybrid sorghum breeding project has been inaugurated. This project should have high priority because a recently discovered mechanism for utilizing hybrid vigour is now available to the sorghum breeder.

Hybrid Maize*: A useful study, "Economics of Hybrid Maize Production in Punjab," has been conducted by T.C.M. personnel. In village maize demonstrations, hybrids were only 12% higher in yield (at 25 mds. per acre) than local varieties when using local practices. In contrast, under recommended practices including nitrogenous fertilizer, hybrids were about 30% higher in yield (at 38 mds. per acre) than local varieties also grown with recommended cultural practices including the same level of nitrogenous fertilizer. The hybrids showed a good profit over extra seed and nitrogen cost, whereas the local varieties, while showing a slight yield increase, did not return a profitable response to nitrogen application.

Plant breeders report that in carefully controlled experiments, hybrid maize breeding material has produced twice as much dry shelled grain per acre as the best local variety. The total yield was over 100 mds. per acre with an application of 80 lbs. of nitrogen per acre.

Recently an intensive coordinated hybrid maize improvement project has been launched. Results achieved to date indicate that outstanding progress can be made, particularly in breeding hybrids that are very responsive to high fertility conditions. Certain U.S. hybrids are useful without further improvement. In launching this project, India has the advantage of being in position to utilize the vast world pool of superior maize germ plasm as well as the accumulated scientific knowledge and experience of maize improvement. Great progress can be and is being made in a relatively short period of time. It is likely that high yielding hybrids may increase the acreage grown to maize.

The breeding work to date on hybrid maize has brought to light the need for work in other fields. Work is needed in agronomy, on fertilization, spacing, etc. Certain diseases and insects may become a limiting factor in production and the breeding work must be done in cooperation with plant pathologists and entomologists, otherwise the full potential of hybrid maize production cannot be realized.

Oil Seed: Oil seeds are an important source of foreign exchange earnings and are a valued food crop. Some plant breeding work has been conducted on oil seeds but it is suggested that breeding work on oil seeds should be materially stepped up. It is also clear that oil seed crops should receive increased emphasis in extension programmes.

Legumes: Gram and pulses are important sources of energy as well as livestock food. These crops have to date received scant attention by the plant breeder. This should be remedied. Work should also be done to seek out and develop superior green manure crops.

We recommend:

The rice and wheat breeding research work should be intensified in the States as well as the Centre to supply the needed high yielding, plant-disease and insect-resistant, stiffer strawed varieties that will respond to higher levels of soil fertility. The production of hybrid maize and sorghum should be intensified because of their immediate potential for increasing production.

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* See Part III, Chapter XA, for a fuller discussion of this subject.

INTERACTION OF IMPROVED CROP VARIETIES WITH OTHER IMPROVED PRACTICES

Improved seeds as a single practice can bring about limited improvement in food production. To be sure, in the event of a catastrophic disease or insect attack a resistant variety even under poor cultural conditions means the difference between a mediocre yield and no crop. *The primary contribution of improved varieties is to raise the genetic ceiling on crop yields to the end that maximum response is attained from the adoption of other improved practices.*

Testing of Improved Varieties

Variety testing at two levels is believed to be necessary. The plant breeder makes preliminary tests on his selections in the early breeding stages. This is done on the experiment station and serves to eliminate the less promising selections. Further testing of varieties considered promising by the plant breeder should next be conducted, comparing such selections to the best available standard varieties. It is further necessary to test new varieties in the cultivators' fields. This type of development research will help bridge the gap between the research farm and the cultivators' fields. It will also further delineate the area of adaptation of each variety and acquaint the state, district, block and village extension workers with the merits and limitations of the new varieties. Actually, certain varieties may have a wider adaptability than is commonly supposed.

We recommend:

There is a critical need for wider testing of new varieties to check the area of adaptation. Regional tests should be more widely employed and should include varieties from all States and Centre, as well as promising exotic varieties.

RICE: SOIL FERTILITY

In most of the rice areas where only a single crop of rice is grown in a year, the summer fallow helps the soil to recoup and the yield is maintained at a fairly uniform level from year to year. This level is, however, low and experiments have definitely shown the great value of both organic and inorganic fertilizers to this crop. One of the easiest methods of supplying organic manure for swamp rice is by growing a green manure crop, often a legume, and turning it into the soil before the rice is planted. This is the cheapest form of manuring rice crop and the practice should be intensified wherever facilities exist or can be provided to grow a green manure crop.

Among the essential nutrients, the greatest need for rice is nitrogen and the response to nitrogen is practically universal throughout the country. Though the response for phosphorus is somewhat lower than for nitrogen, the need for phosphorus also exists in most rice areas. In fact, in some areas as in Assam, parts of Madhya Pradesh and Bihar, phosphorus is the limiting factor to increased rice production. No response is obtained for nitrogen without the addition of phosphorus.

The all-India fertilizer trials in the cultivators' fields have shown that response to nitrogen (30 lbs. per acre) is high in all places and

that the increases in yield range from 330 to 866 lbs. per acre. The response to an equal quantity of phosphorus is more variable and ranges from 90 to 940 lbs. per acre. The response to nitrogen over phosphates is more definite according to the soil type. It is low in coastal alluvium and in laterite soils, but high in medium black, red and gravelly soils. The trials have shown that the response to nitrogen and phosphates obtained in cultivators' fields are much higher than those obtained in experimental stations in earlier years.

Besides nitrogen and phosphorus, special areas have shown response to potash. Although ammonium sulphate has been the chief nitrogenous fertilizer in use so far, experiments have shown that other more concentrated fertilizers like urea and ammonium nitrate can give equally satisfactory results. Though in some areas the efficiency of these fertilizers may be somewhat lower than ammonium sulphate, greater concentration of nitrogen and less cost per pound of nitrogen are points in their favour.

With regard to the requirements of fertilizers, it is to be understood that organic manures and chemical fertilizers are different in their functions and have to be looked upon as complementary agents in crop production, rather than as a substitute for each other.

In spite of the limited supply of fertilizer, perhaps only 30 to 40 per cent of the available fertilizer is used on food crops. This percentage may vary in different States. Other crops which compete for fertilizer are sugar-cane, cotton, jute, etc.

Research: The extensive fertilizer trials are providing critical information on the optimum quantities of the fertilizer to be used for different rice areas of India. Fundamental to the use of fertilizers is the study of the chemistry of swamp soils. This has not received much attention in India so far. Work would particularly be desirable to obtain information on the availability of particular nutrients as a result of the swamp conditions under which the plant grows. For example, the rice plant needs considerable amount of silica and iron which the plant can utilize only under swamp conditions.

Connected with the use of fertilizers, investigations would also appear necessary to determine how much of the nutrients applied to the soil is actually utilized by the plant. Information is lacking on the question of absorption and assimilation of nutrients by the rice plant at different phases of its growth. It is only such information that can ultimately lead to more dependable data on the quantities of nutrients to be applied and how and when they are to be applied to get the maximum benefit.

Our conclusions are:

Experiments both at the Central Rice Research Institute, at other experiment stations, and in the cultivators' fields have shown that application of nitrogen in the form of ammonium sulphate in sub-surface (plough sole) is much more efficient than surface application. This practice should be advocated for adoption in all rice growing areas.

Organic manures and chemical fertilizers are complementary in function and since organic manures cannot be relied upon to achieve immediate production goals, a high priority must be given to the use of chemical fertilizers. To obtain efficient fertilizer utilization more

attention should be given to certain factors such as: N.P.K. ratios, timing of applications, split applications and placement.

Some information is available on the quantity of water necessary for maturing a rice crop, but critical data are not available about the optimum requirements. Investigations are particularly necessary to determine the requirements of the plant at different phases of its growth. Experimental work in Japan has shown that by regulating water supply according to the requirements at different growth phases, it is possible to economize in water supply to an extent of 20% without any reduction in yield. The experiments involve periodical drying of the fields by cutting off water supply, and it has been established that such periodical drying tends also to improve the fertility of the soil.

Continuous rice cultivation under anaerobic conditions tends to make the soil heavier and this reduces percolation. Though rice may be grown under submerged conditions, the importance of drainage has not been sufficiently realized. The growing of the crop under submerged conditions brings about a number of physical and chemical changes in the soil, such as increase in p^H, an increase in specific conductance and a decrease in redox potential.

Among the more important chemical changes arising out of submersion may be mentioned the reduction of iron and manganese, increase in the solubility of phosphates, transformation of nitrogen to nitrate and ammonia and increase in the solubility of silica. Among the biological changes, fixation of nitrogen by algae is the most important long-term benefit to rice accruing from submersion of soils.

Additional research work is needed on all cereal crops on water management since it is obvious that substantial increases in yields can be obtained through proper and efficient irrigation practices. For example, experiments on variety X fertilizer X water management combination are important.

When the Japanese method of rice cultivation was first taken up it was decided by research workers that careful experiments should be undertaken to assess the value of the individual features of the Japanese method, in their contribution to increased yield. The results of these experiments over an average of 3 years have shown unmistakably that manuring (including use of organic and inorganic fertilizers) makes the largest contribution, that is about 60 to 70 per cent, to increased production. The overall average increase due to manure under the Japanese method was about 7mds. of paddy per acre and the increase due to the adoption of cultural practices associated with the Japanese method was about 2 mds.

Since most of the cultural practices associated with the Japanese method are more rational and often can lead to economy in labour particularly due to the introduction of line planting and interculturing with the rotary hoe, it may be said that the introduction of Japanese method of rice cultivation has great possibilities of improving the acre yields wherever it is practised. *It is, therefore, necessary that in attempts to increase acre yields, the Japanese method of intensive cultivation of rice should be extended to practically all irrigated areas. It should be mentioned that the essential elements of the "Japanese method" are related and the lack of any one of these elements is likely to*

reduce the efficiency of the others. The lack of commercial fertilizer will reduce the production potential of the system.

MECHANIZATION

There has been no significant improvement in India in the implements used by the cultivator. In most cases mechanization may not increase yields; therefore, emphasis should be placed on certain phases of production where it can be shown that mechanization will actually increase production. In the river valleys and deltas the soil is generally heavy and dries up during the fallow season. With the existing animal power, preparation of the soil can begin only when the land is irrigated or soaked by rain. Under these conditions, if the soil could be more quickly and better prepared by mechanical equipment, crops could be planted on time and significant increase in yields could be obtained.

In many areas, due to the cost and scarcity of labour, crops are not harvested on time which results in the loss of grain and in milling quality of the grain. In general, land holdings in India are small, therefore only small size and comparatively simple equipment can be used to supplement animal power. Certain hand-operated tools such as the rotary weeder, pedal thresher and line seeding planters should be more widely adopted, while animal-drawn equipment such as the mouldboard plough and harvesters should be emphasized. The rotary weeder is becoming very popular with the rice growers and similar equipment could be used for other crops such as wheat. Japanese-type garden tractors could be utilized in the timely preparation of the soil.

Opportunities for individual cultivators with small land holdings to own improved equipment is still limited because sufficient work is not available for the efficient use of the equipment. Joint ownership by farmers or ownership by cooperative societies seems feasible.

In limited areas where land holdings are sufficiently large, tractors are popular. These tractors are used on individual farms and are hired out to other farmers so that land can be prepared in time for proper seeding. The charges vary from Rs. 15 to Rs. 20 per acre. Thus private enterprise may operate very effectively here, especially for soil preparation and grain threshing.

Recommendations are as follows: (1) *A strong engineering department is needed at some centre where imported equipment can be checked for adaptability, present equipment can be improved in design, and new equipment can be designed for rice production.* (2) *In the breeding work, emphasis should be placed on development of varieties suitable for mechanization.* (3) *More applied research is needed to determine how mechanization can fit in with overall cultural practices.* (4) *Educational work should be expanded on the maintenance and proper use of mechanical equipment.*

PLANT PROTECTION

It is widely recognized that insects and plant diseases play an important role in any crop production programme. Lack of insect and plant disease control reduces the effectiveness of improved practices such as the use of improved seed, fertlizer applications and irrigation. As mentioned earlier in this report, the use of resistant varieties is the most economical means of controlling insects and dis-

eases. However, resistant varieties have not been developed in many cases, especially in the case of insects, and insecticides and fungicides must be utilized. Also, in the control of many insects, for example locusts, the use of chemicals is the only feasible solution.

Fungicides are rarely used for the control of foliar diseases on cereal crops but are used extensively on fruit and vegetable crops. With cereals the applications of protectants are not generally considered to be economically justifiable, other than seed treatment for control of seedlings diseases and certain smuts. Insecticides, on the other hand, are widely used for the control of insects on cereals, fruits and vegetables. The very low yields in India of many crops have retarded the use of insecticides and fungicides because of economic considerations. However, as crop yields are increased by other scientific practices plant protection will play an ever-increasing role in crop production.

Realizing the importance of plant protection, the Government of India and the States have entrusted the work to special full-time staff. The organizational set-up varies somewhat from State to State and more progress has been made in some States than others in implementing the programme.

The field of entomology is not adequately covered in this report. However, in one State, Punjab, an attempt was made to collect the pertinent information on the insect control programme. In this State over 250 species (3 dozen major pests) of insects, plus a few species of mammals and anthropods, were reported to infest cereal crops, fruit trees, vegetables and stored products. Punjab's losses were estimated at over 18 crores annually.

The State entomologist was located at the government agricultural college and had the duties of Professor of Entomology, research entomologist, plant protection officer, and state locust control officer. There appeared to be good correlation between teaching, research and plant protection.

The objectives as set forth by the plant protection officer were as follows:

Research—To develop efficient and timely control practices and to forecast pest incidence; teaching—to train research and extension workers; plant protection—to demonstrate control methods, to organize campaigns in case of epidemics, to develop and maintain warning service, and to help cultivators in obtaining supplies and materials; locust control—to maintain liaison with national and international forecasting systems and to issue warning, to organize training and control, and to aid in meeting the pesticide and equipment demand.

The Punjab plant protection organization at the present time maintains 22 centres staffed with one plant protection inspector, one sub-inspector and 3-4 fieldmen. The organization possesses application equipment consisting of 28 power dusters, 34 power sprayers, about 1700 hand-operated sprayers and about 4300 hand rotary dusters. In addition, the organization plans to make very significant additions in equipment and personnel during the remainder of the Second Five Year Plan and during the Third Five Year Plan.

Also equipment is being purchased at the block level for rental or issue at subsidized rates to the farmers. This was deemed necessary not only for better pest control but to meet the demands of the cultivator for pest control.* Maintenance of power duster and sprayer equipment is a serious problem, so two mobile workshops were planned for maintenance and repair of equipment.

The above discussion points out the needs for pest control and some of the steps that are being taken to meet the gigantic challenge. At the present time only a small percentage of food crops (on acreage basis) are adequately protected from diseases and insects.

Pest control has its full complement of problems. Some of the more important problems are:

(1) Supply of Pesticides — A regular supply of pesticides is necessary. Recently, the plant protection adviser to the Indian Government proposed centralized imports on rate contracts for pesticides on a national basis to better the supply situation.

(2) Personnel and Equipment — Personnel and equipment are far from adequate. There are not sufficient personnel to make the necessary surveys for disease outbreaks and plant disease epidemics; therefore timely control is often impossible. More cultivators should own hand equipment individually or cooperatively. In cases where large outbreaks of pests occur, ground mobile or aerial spraying and dusting equipment should be emphasized.

(3) Cooperation — The need for close cooperation between plant protection personnel and the research centres should be emphasized and timely refresher courses for plant protection personnel are necessary. New plant protection materials are continually being developed and up-to-date information is necessary on the selectivity, timing, rate and number of applications and toxicity hazards of various pesticides.

(4) Toxicity — Certain pesticides are toxic to fish in tanks and due precaution should be exercised in pesticide applications. As more pesticides are used, residues on foods may become a problem, and fuller implementation of pure food and drug laws will be necessary.

Rats: In certain areas, damage by rats to crops is reported to be greater than damage by insects. In South India damage may be caused by the mole rat, the grass rat and the antelope rat. The mole rat is the most destructive and is controlled by the use of the bow trap and by digging into the burrows and killing the rats. The grass rat which comes out at night can be destroyed when dazed with strong lights, or can be controlled by zinc phosphide baits. The antelope rat is a shallow burrower and can be disturbed from the burrow and destroyed. Baiting with warfarin is reported to give good control of the field rat. Control measures on any species of rat have to be done on a community basis in order to achieve an effective and permanent measure of control and the present rat-control programme in India should be intensified.

NEMATODE DISEASES

Nematode diseases are being recognized more and more as a

* For example, rupees four lakhs worth of pesticides were used in 1957-58 and the demand was expected to increase by 250 per cent during the current year.

threat to efficient agricultural production. In fact, it has been shown that losses in crop yields formerly attributed to drought and nutritional deficiencies are in reality caused by nematode diseases and that poor fertilizer response may be due to nematode diseases. These findings have greatly stimulated the work in this field.

Parasitic nematodes attack most crops, including vegetables, fruits, ornamentals, cereals and even forest trees. The role of certain ectoparasitic nematodes which attack the roots of cereals such as rice, wheat and maize has not been well defined and too little work has been done in this area. Here, special consideration should be given to diseases caused by nematode—fungous complexes. Foliar nematode diseases on cereals have received more attention.

Plant pathologists in India recognize the need for increased work in nematology, but here, as in many other countries, necessary personnel and facilities are not available to make the necessary surveys and do the basic and applied work which is urgently needed. Work should be focused on the control of nematode diseases by crop rotation and the application of nematocides. Also breeding work affords an excellent opportunity for developing nematode-resistant varieties.* The proposed scheme in India for more work on nematode diseases is highly recommended.

WEED CONTROL

Weed control is an essential part of any cultural system designed to produce high yields. It has been reported that weeds in rice fields may reduce yields 30 per cent. The importance of weed control is recognized, yet control practices are not always used because weeding is usually done by hand and is a time-consuming and costly practice. In non-irrigated areas, the value of the crop is often not sufficient to allow for large expenditures for weed control.

Weed control normally falls into three categories, that is: cultural, mechanical and chemical. Under cultural practices, factors such as good land preparation, deep ploughing and planting in rows to facilitate cultivation are important. So far as mechanical control of weeds is concerned, more emphasis must be placed on mechanization. For example, equipment of the rotary weeder type used on paddy cultivation could be more widely adopted. The use of mechanical equipment is often the least expensive method of weed control.

The use of herbicides for the control of weeds in certain crops appears promising. For example, studies have been conducted at the Central Rice Institute at Cuttack for several years on the control of weeds in rice fields with herbicides such as Agroxone-3, Phenoxylene-30, Chloroxone, shell 2, 4-D, and 2, 4, 5-T and significant yield increases were obtained with the first three mentioned herbicides. Herbicides gave as good weed control as the use of the rotary weeder and hand weeding. However, the use of the rotary weeder appeared to be the least expensive. As labour costs increase, the use of herbicides may become more important. For example, in Japan the use of 2, 4-D has reduced labour costs for weeding in rice by about 40 per cent.**

* For example, an important nematode disease in the U.S., known as "White tip," is controlled by the use of resistant varieties.

**In India the use of herbicides has been proved to be a practical and economical means of controlling weeds in wheat.

Schemes for reducing losses due to weeds are difficult to propose because sufficient fundamental and applied data are not available. Certainly, attention should be given to the purity of seed in the seed multiplication schemes so that the spread of noxious weed seed can be kept to a minimum. Mechanical control of weeds should be emphasized.

For example, the Japanese rotary weeder is being used effectively in rice cultivation and similar equipment could be used for other crops. More research work should be done on improvement of present equipment and development of new equipment for weed control. Research on pre- and post-energence chemicals for weed control should be emphasized since as labour costs increase, the use of chemicals for weed control may be important in India's future food production programme.

RESEARCH

There is need for more trained research scientists to work on the many problems confronting agricultural production. Because salaries are often low, advancement in class in existing organizations is difficult and retirement policies are unrealistic, maximum efficiency is not obtained from the scientists now in service. Research cannot be done effectively on a short-time basis and the movement of men from one organization to another in order to obtain promotion creates inefficiency in research organizations.

More attention should be given to library facilities in various State centres. Current research work in some instances may be out of date and unnecessary because the workers have not had the opportunity to check the world literature on the project concerned.

CHAPTER X. THE MULTIPLICATION AND DISTRIBUTION OF IMPROVED SEEDS

India's food crisis requires that improved seed make a greater contribution to increased crop production. Plant breeders have developed high-yielding varieties, possessing good adaptation; and with continuing support of plant breeding, even better varieties will be evolved in the future.

Improved varieties do not contribute to increasing crop production, however, until high quality seed, of the best varieties, is planted by the cultivators. Seed schemes in operation throughout India have made some progress. However, in the light of the critical needs for more food there is great need for seeking out and putting into effect ways by which improved seed can reach the cultivators, fields and make a greater contribution to increased production. This chapter embodies results of the Team's investigations, interviews and observations. Specific recommendations are made which, if implemented, will help materially to increase food production.

The use of highest yielding adapted crop varieties by the cultivators is one of the most economical means of increasing agricultural production. Seed is a basic crop production cost, and is a cost present whether cultivators use good or poor seed. It is thus vital that only the best seed be used.

The plant breeder by combining, in an improved variety, high yield, disease resistance, wide adaptation, and added responsiveness to fertilizer, irrigation and good management, has provided a built-in permanent improvement in the variety. *Thus the benefits derived from improved seed costs the cultivator little if any more than seed of unimproved varieties.*

Improved seeds have superiority over local *(desi)* seeds under average cultural conditions. Furthermore, in the event of a catastrophic disease or insect attack, a resistant variety, even under low fertility, means the difference between a crop failure and at least a subsistence crop, even though the yield may be low. *But it is under conditions of high fertility and good crop management that improved seeds make the greatest contribution to increased production.*

To be sure there are difficulties in inducing many village cultivators to accept even one improved practice at a time. Yet really significant increases in production can be attained *only* if cultivators adopt a combination of several of the right improved practices including improved seed.

India has made some good progress in getting new seed to the cultivators. But the Team was unable to get what we felt was clear verifiable data on the extent to which improved seeds are actually used on village fields. There is evidence that, from the VLW on up, there is a feeling of complacency unwarranted by actually verifiable facts.

Data on and reports of acreage planted to improved crop varieties are obtained from several sources. Crop-cutting data obtained by the Revenue Department on a random sample basis is one such source of information. Agricultural officers also make estimates on the acreage planted to improved seed distributed to cultivators, taking

into account natural spread. There is a tendency to overestimate. In any event the quality, good or bad, of the seed planted is not taken into account.

No effort has been made to verify reports of the acreage planted to improved seeds. It is of interest that in rice and wheat, a very high percentage is alleged to be planted to improved seeds. Yet only limited progress in some States has been made in increasing rice and wheat yields.

If improved varieties are as much superior over local varieties as the research data indicate, one of four conclusions must be drawn: (1) the reports of acreage planted to improved varieties are greatly exagerated; (2) seed of such low quality (planting value) is used as to prevent full demonstration of the varieties' high yield potential; (3) in cultivators' fields the improved varieties fail to give the expected yield increase; or (4) other improved practices to enhance yield potentials of improved varieties are not followed by the cultivators.

1. ORGANIZING TO SOLVE THE PROBLEM

Creating a good demand for improved seeds, without having adequate supplies to fill the demand, is just as futile as to have large supplies with no farm demand. The supply of improved seed must be developed under leadership of the same broad Government agency that created the variety and developed the demand. This requires competent integration.

In the successful multiplication of improved seeds there are a series of steps, each of which must be expertly carried out if the cultivator is to obtain full benefit from improvements built into the variety by the breeder. These steps are the basic principles of a sound seed programme and are the same the world over.

Organizing and Training a Seed Specialist Cadre

The multiplication and distribution to cultivators of genetically pure seed of high quality of improved crop varieties requires a high degree of specialization. Seed of an improved variety is a living organism possessing genes which assure superior performance only when high genetic purity is maintained and the seed is of good quality.

Under the circumstances of India's acute shortage of trained manpower and its urgent need for increased agricultural production, the State departments of agriculture have done a remarkable job on improved seed programmes. The improved seed multiplication and distribution function has been carried by State, district, block and village workers in addition to their many other duties. It must, *however, be recognized that India's improved seed programme is today fulfilling only a small fraction of the increasing demands which will be made on it in the years ahead.* There are increasing needs and demands for improved seed of better quality and in greater quantities.

The Team recommends that a cadre of trained seed specialists be recruited, trained and organized at the earliest possible moment. The need is so great, and so essential to the whole improved seed programme that the setting up of such a cadre is given as our first recommendation. The recommendation is based on the knowledge that in no country is high-quality seed of improved varieties success-

fully produced except under the direction and leadership of competent specialists. India is no exception. The Team's inquiries revealed that in situations where competent specialists supervised the work, the seed multiplication was well conducted. In other situations (and these are the majority), seed which was badly mixed as to varietal purity and unsatisfactory in other quality factors was being produced. Seed of unsatisfactory quality was therefore being produced, even though in some instances officials—from the VLW up to state officers—expressed satisfaction with the progress being made.

To provide continuity in improved seed multiplication schemes it is necessary to keep seed specialists at seed posts. Seed multiplication is not an administrative type of post where a generalist can be effective. It is necessary to provide advancement and inducement for deserving seed specialists in this field of specialization.

Levels of Specialists Needed in Centre and States

It is recommended that a cadre of seed specialists at the following levels be trained and recruited as early as possible:

At the Centre: A botanist with post-graduate training or suitable experience and competence in improved seed programmes is needed at the Centre. This specialist will require intimate knowledge of improved seed production techniques and procedures for the wide variety of crops found in India. His primary role would be to work towards expediting recommendations made by the Centre Expert Seed Committee and by other Centre committees or officials concerned with improved seed schemes. Leadership qualities are thus of paramount importance.

The specialist should be the leader in developing special training for seed specialists at the State, district and block levels. He would work towards the development of uniform seed certification standards and seed legislation among the States for the several crops, and maintain liaison with improved seed development in other countries. In seed supply, such a specialist could act as a clearing house for information regarding available supplies of improved seeds. This will help expedite seed movement between States.

The Centre specialist's primary role should be one of teaching and leadership in organizing improved seed schemes.

In the States: Here a counterpart post to the one recommended for the Centre should be set up, under a specialist with comparable training and ability, such as a botanist with improved seed programme competence. This post should correspond in level to the Deputy Director of Agriculture. The specialist should preferably be responsible to the top administrative officer in State agricultural extension. The specialist's primary responsibility should be seed training of district, block and village workers. The specialist could also advantageously assume overall technical responsibility for operation of the Government seed farms.

His other functions would be development of State seed certification standards; maintenance of contact with the Centre, other States and districts on supplies of the various classes of certified seed; preparation of teaching information on recommended crop varieties. In general, he should work towards the maximum use of improved crop

varieties in association with other improved crop production practices. It is especially important that the State seed specialist maintain close contact with plant breeding research stations.

At the District Level: It is recommended that seed specialists also be established at the district level and made responsible to the State seed specialist. Depending on the local situation, one specialist may occasionally serve more than one district. Seed specialists in districts should be agricultural college graduates with plant breeding and agronomy training and the needed "in-service" training in seed technology and improved seed programmes.

District specialists would adapt improved seed recommendations for use at the block and village levels. They should provide training for personnel making village field and seed inspections. They would coordinate certified seed supply needs from within the district and from outside of the district. While their work as district seed specialists would be primarily directed to training block and village level workers, it must be borne in mind that until cooperative and private dealers are developed, the agriculture departments will continue to supply seed to the cultivators. Upgrading of certified seed quality through training of seed inspectors and supply coordination will therefore be an important function of district seed specialists.

At the Block Level: The Government has set a goal of a Government seed farm to serve each block. The Team recommends that direct supervision of Government seed farms for Foundation seed production, whenever feasible, be placed under the direction and supervision of a trained seed specialist at the block level. A resident seed farm manager would in most cases also be necessary to conduct day-to-day operations. In most blocks, as the occasion demands, it is recommended that one of the four additional block specialists recommended in the section on extension be primarily responsible for improved seeds. In technical matters, such as inspections for certification, this block specialist should be administratively responsible to the district seed specialist or appropriate District Agricultural Officer.

A block seed specialist would be valuable in assuring high quality of Foundation, Registered, and Certified seed. He could personally train department of agriculture personnel making field and seed inspections at the village level. He should, until an agriculture department certification staff is developed, personally make a large share of the necessary field and seed inspections. This is particularly true if Certified seed multiplication is concentrated on larger land holdings or in special seed multiplication villages. The block seed specialist should also aid in popularizing improved seeds through working side by side with the village level worker in establishing demonstrations and related teaching devices.

At the Village Level: A high degree of seed specialization is not feasible at the village level. The VLW should receive training on improved seed through the State, district and block seed specialists. Such training should be properly interrelated to training in other crop production practices. The VLW should primarily be a demonstrator and village teacher of improved seed practices. *As soon as possible, he should be relieved of improved seed supply and seed inspection functions.* Except by intense and adequate training, the VLW cannot become a satisfactory improved seed production specialist.

Seed Training Programmes

Adequate training of the proposed Centre, State, district and block seed specialists is a formidable task. It is nevertheless a need which cannot be postponed if India is to capitalize on improved seed, one of the most economical means of increasing food production. Full utilization of improved varieties will be achieved to the extent that village cultivators plant high quality improved seed in combination with other improved practices. This will require a large quantity of Certified seed of improved varieties backed by a strong educational programme.

If the VLW supervises the production and distribution of improved seed, this job conflicts with his primary role as a teacher. As the improved seed programme grows, such supply and supervision tasks will require an increasing amount of his time and the VLW and the agricultural extension officer will tend to primarily be shopkeepers, unless cooperatives assume the supply role. Moreover, the inspection of seed tends to be a regulatory function.

After recruitment of personnel with the necessary basic education, the training of the State, district and block seed specialists can be accomplished by a series of special seed-training courses with emphasis on field work. Instruction would be furnished by the State and Centre plant breeders, agronomists, foreign seed specialists and Indian specialists who have received seed training in other countries. In such recruitment and training programmes, it is suggested that maximum use be made of the existing staff.

As cooperatives assume an increasing part in the business of supplying improved seeds to the cultivators, there will be continuing need for the seed specialists. These specialists at all levels will continue to train and supervise seed inspectors. The planning and integration of improved seed supplies with demand, and the developing of educational programmes on seed, will be the function of all specialists. Technical information needed by cooperatives should be supplied by the seed specialists.

For India, neither an improved seed scheme nor seed specialist training can be adopted directly from other countries. Any successful scheme must be suited to conditions and problems as they are found in India. Nevertheless, certain fundamentals of improved seed programmes are common to all countries. It is these basic fundamentals that India should adopt.

Three Aspects of Solving the Improved Seed Problem

Bridging the gap between the development of an improved variety and widespread use by cultivators involves three primary aspects. These are:

1. *Education* — Before seed of an improved variety is purchased by a cultivator, demand must be created. With 65,000,000 farm families in India, this is a stupendous task. To further magnify the problem, cultivators must also be taught how best to use improved seeds with other improved practices. Natural spread of improved seeds is slow, and unfortunately the spread is usually not associated with other good cultural practices. Conservatism and high rate of

illiteracy in villages requires successful demonstrations which include several of the most important improved practices. This requires skill in the VLW. There is great need for intense field training of extension workers in how to establish good multifactor demonstrations.

Meetings, posters, campaigns, radio and other means should also be used. In the end, it is believed that the cultivator changes practices when he sees results with his own eyes. Good experience has been gained with multifactor demonstrations in hybrid maize, wheat, rice, and with crop competitions. These are a valuable guide.

2. *Seed Supply — Production and Distribution* — This is a specialized function. Successful improved seed production must follow prescribed techniques to maintain high genetic purity and satisfactory seed quality. This is a specialized service job. As we have already noted, extension workers, particularly the VLW, should be relieved of this role as quickly as possible.

3. *Certification* — This regulatory activity is not well developed for improved seeds in India. It should preferably be performed by agricultural officers other than the VLW. It is believed that with careful planning and concentration of seed multiplication, seed inspection can be performed by department of agriculture staff operating from block and district headquarters.

In India these three basic primary aspects of improved seed programming are now performed by the State departments of agriculture, and at the block level in cooperation with community development. As an interim measure, it has been necessary for the respective States to combine these three distinct functions.

For some time to come the State departments of agriculture will necessarily continue to conduct at least a portion of the three aspects of improved seed programmes. The three aspects should, however, be separated into three distinct functions as soon as possible. Under such separation, cooperatives and private growers should assume the supply role, community development and agriculture departments should assume the educational functions, and agriculture departments should assume the inspection function.

In the transitional period, i.e. between the present time when State Governments handle the seed supply function and the time later when this activity is assumed by service cooperatives and private dealers, it is urged that provision be made for relieving the village level workers of inspection and supply work. An orderly transition can thus be made in the separation of education, improved seed supply, and certification.

The block cooperative officer should be assigned the duty of organizing and arranging for cooperatives to assume responsibility for distribution of Certified seed to village cultivators, along with other agricultural supplies. Plans for needed improved seed production should be developed by the block seed specialist in cooperation with district seed specialist and the block cooperative officer.

The Need for Uniform Nomenclature and Quality Standards

The increased yield potential of an improved variety is entirely or partially lost when the cultivator plants seed which is mixed, is of less than 90% or better germination, or is contaminated with weeds and other crops or infected with seed-borne diseases. The widespread

use of improved crop varieties associated with seed of high quality must go hand in hand if the improved varieties are to make their full contribution to increased food production.

There is good evidence that administrative, research and extension officers of the States, and the cultivators, are relying on the mere spread or saturation of improved varieties to bring about increased production.

In India seed laboratories do not exist which are equipped to test seed properly for germination, purity, weed and other crop seed content and presence of seed-borne disease. It is therefore apparent that little is actually known about the *quality* of the seed planted by the village cultivator. This lack of knowledge has resulted in unwarranted complacency about the poor seed used by a large share of the cultivators.

A start has been made in some States in the seed testing of Foundation and some of the Registered and Certified seed. Standardized procedures and rigid minimum seed quality standards are, however, not followed.

A general improvement in the quality of seed used by the cultivator would result if all Breeder, Foundation, Registered and Certified seed handled or distributed under State Government auspices were tested in properly equipped official seed laboratories. If large quantities of high quality pure Certified seed were distributed, varietal contamination and quality deterioration would be minimized in the last *one or two* stages of village seed increase. Under such a scheme, it would be imperative that seed failing to meet the minimum seed certification quality standards should be rejected.

Nomenclature and Definition

In India the multiplication of improved seed is primarily a State function. Though there is some effort in this direction, there is lack of sufficient uniformity among the States in the generation sequence and nomenclature followed in the multiplication of seed. *To facilitate the development of uniform seed-certification standards among all States, it is important that there be a uniform nomenclature and definition for each succeeding generation of improved seed.* Seed uniformity would facilitate the movement of the various classes of seed from one State to another.

The following nomenclature and definition for succeeding generations of Certified seed approved by F.A.O.* are recommended for use in India.**

(a) *Breeder Seed:*

Breeder seed is seed directly controlled by the originating, or in certain cases, the sponsoring plant breeder or institution, and which provides the source for the initial and recurring increase of Foundation seed

* Minimum Seed Certification Standards for Cereals in the Near East. Food and Agriculture Organization of the United Nations.

**The Indian nomenclature for the classes of seed included in seed schemes are listed in various States as nucleus, Breeders stock, Foundation and Registered or Breeders, nucleus, Class A, Class B, Class C and other variations of the above terminology.

(b) *Foundation Seed:*

Foundation seed shall be seed stocks that are so handled as to most nearly maintain specific genetic identity and purity and that may be designated or distributed by an agricultural experiment station.

Production must be carefully supervised or approved by suitable representatives of the appropriate Government agency. Foundation seed shall be the source of all other Certified seed classes, either directly or through Registered seed.

(c) *Registered Seed:*

Registered seed shall be the progeny of Foundation or Registered seed that is so handled as to maintain satisfactory genetic identity and purity, and that has been approved and certified by the certifying agency. This class of seed should be of a quality suitable for the production of Certified seed.

(d) *Certified Seed:*

Certified seed shall be the progeny of Foundation, Registered, or Certified seed that is so handled as to maintain satisfactory genetic identity and purity and that has been approved and certified by the certifying agency.

The Breeder, Foundation and Registered seed classes are primarily intended as stock seed (for further multiplication), while the Certified class is the large volume of seed to be planted by the cultivators. In actual village use, Registered and Certified seed may overlap, though Certified seed should never be used to produce Registered seed. In hybrid maize and hybrid sorghum, the generation sequence is Breeder, Foundation and Certified.

Seed Quality Standards

In India nearly all the organized multiplication and distribution of improved seed are conducted by the State agricultural departments. It may therefore appear that the development and enforcement of uniform minimum seed certification standards would be unnecessary. It must, however, be borne in mind that in each State a large number of agricultural officers with varying degrees of training and seed competence inspect, store and distribute seed. Minimum certification standards for all improved seed handled in the organized scheme would assure a uniformly high quality for all Certified seed. It would also be a common reference in improved seed and would serve as a training aid for all officers engaged in improved seed activities. Further, there is some movement of improved seed from State to State. Uniform standards of seed quality for each class of seed among all of the States would facilitate such movement.

There is evidence that there is now much variability in seed quality between States. This could be remedied by the development and enforcement of uniform certification standards.

As a matter of policy, the Centre and State Governments are moving towards development of supply and service cooperatives to take over the function of supplying improved seed to the cultivators. A desirable development would be for these cooperatives to assume

responsibility for the contract production of all stages of seed increase after the Foundation or Registered seed level.

Private seed producers and dealers should also be encouraged to engage in seed multiplication and distribution. In such situations a technically trained staff is necessary.

It is recognized that for some time to come the State Governments will necessarily handle a large share of the improved seeds. Whether this function is performed by the Government, cooperatives or private growers, it is recommended that minimum seed certification standards be adopted by each State as soon as possible. These standards should be specific for genetic purity and all important seed quality factors. The minimum standards adopted by F.A.O., European countries or the United States and Canada can, where applicable, serve as a guide.

Improved Seed Multiplication

Maintenance of Varietal Purity.

In self-pollinated crops, the primary problem in maintaining high genetic purity is to prevent occurrence of mechanical mixture through mixing in planting, harvesting, threshing, storage, or contamination from volunteer plants in the field and occasionally also by natural crossing.

In multiplying pure seed of improved varieties of cross fertilized crops, there is the additional hazard of contamination from wind or insect-transported foreign pollen. In such cases, sufficient isolation must be provided. A limited (3 to 4) seed-generation sequence is especially important in cross-fertilized crops. The distance requirements for isolation should be greater for the Breeder and Foundation seed multiplication fields than for fields producing Certified seed.

Multiplication of hybrid maize and hybrid sorghum seed by use of the male sterility mechanism requires expert handling of the plant material and special care to prevent contamination.

Maintenance of Breeder Seed

The inclination for a plant breeder in India as elsewhere is to consider his duty towards improvement of a particular variety complete when seed multiplication has been started. *The plant breeder has, however, a continuing responsibility to maintain recurring supplies of genetically pure Breeder seed as long as the variety is included in a seed multiplication scheme.* Since the plant breeder is familiar with the characteristics of each improved variety, it is necessary that he and his assistants maintain the Breeder seed.

In some instances (such as for foreign variety introductions or for a variety in use after the originating breeder has left the service), it will be necessary for plant breeders other than the originator to maintain Breeder seed. In any event, the requisite staff to maintain Breeder seed should be provided.

Very minute genetic contamination at the Breeder seed level is multiplied several fold before seed reaches the cultivator in Certified seed. Often such contamination cannot be successfully rogued. For example, mixed varieties may be similar or the field lodged. Further-

more, roguing of the larger acreages producing Foundation, Registered or Certified seed is much more costly than the use of extreme care in maintaining 100% pure Breeder seed. The heavy cost of roguing seed multiplication fields in India would be materially reduced if genetically pure Breeder, Foundation and Registered seed were available. The cultivators would also obtain Certified seed of higher genetic purity.

Government Stock Seed Farms

A Government Stock Seed Farm is provided for India's present overall seed scheme to serve each block with its requirements of Foundation seed. Registered and Certified seed are to be produced at the village level using Foundation as stock seed. This scheme organizes the multiplication and distribution of improved seeds on the basis of individual development blocks. The requisite number of seed stores are to be established to serve cultivators with a timely supply of improved seeds.

This decentralized stock seed scheme is particularly applicable to the multiplication of seed of self-fertilized crops such as rice and wheat. Modifications because of isolation problems are required for most cross-fertilized seed.

The Government Seed Farms multiply Foundation seed using Breeder seed provided by the plant breeding experiment stations as planting stock. This has the effect of decentralizing seed multiplication efforts and takes into account the acute problems of transportation and communications in rural India. The plan is well conceived in principle and there is evidence that progress is being made in speeding up the spread of improved crop varieties to the cultivator.

While the proposal has been made that a seed farm of about 25 acres in size should serve each block, it is also recognized that it is sometimes desirable to deviate from this size pattern. For example, in the South, where land holdings are small, a smaller acreage may have to suffice. On the other hand, some States are finding it necessary to establish seed farms of larger size. Thus one farm may serve several blocks. This is feasible if the farm is strategically located.

The larger efficiently managed seed farms will serve India's improved seed needs better than rigid adherence to proposals for one small farm for each block. This is because trained seed specialists are not available to manage competently the very large number of smaller farms on a one-per-block basis. Further, some mechanization is necessary. This is better suited to the larger farms serving several blocks. To speed up the spread of new improved varieties, effective effort must be made to produce maximum yields of Foundation seed (the early generation). It is also important that Government seed farms be self-supporting.

The Government Seed Farm must be treated as only one step in bringing the improved seed from the plant breeder to the cultivator. It is a vital step because, as conceived, it assures continuing waves of high quality Foundation seed for the next two steps—the Registered and Certified.

All Government farms, whether regular block seed farm, or others which are suitable and used for stock seed production, should be

so managed as to produce maximum yields of high quality seed. This will require the use of the best crop culture including high fertility, plant protection, water management, etc. Competent management is necessary. On farms currently operated, there is evidence that, on occasion, seed of unacceptable quality is produced and distributed. This will tend to destroy the cultivators' confidence in the Government seed scheme.

Wherever feasible it is recommended that the block seed specialist be assigned technical supervision of the Government Seed Farms.

In the urgency of spreading the use of improved seeds, it is evident that State Governments have purchased and distributed directly, or as an agent, considerable quantities of seeds of inferior quality. Such seed has on occasion been badly mixed as to variety, and Registered and Certified seed has been distributed without accurate of knowledge of varietal purity of seed quality. If appreciation for and knowledge of high seed quality is to be developed by cultivators and Government employees, it is imperative that only seed meeting established certification standards for germination, purity and seed quality be distributed by the State Governments or under their auspices.

The *sawai* system of seed distribution is a convenient credit device, but there is good evidence that nondescript seed of poor quality is distributed under this scheme.

Multiplying Seed for the Villages.

Procedures and seed production facilities to bring about the final stage of seed multiplication must necessarily be adapted to the type of crop and seed multiplication problems. A different scheme will be needed for self-fertilized crops as contrasted to cross-fertilized and hybrid crops. A special section of this report is devoted to hybrid maize seed

In the multiplication of certified seed of self and some cross-fertilized crops three general alternatives are available.

Village Seed Farms

In multiplying seed of self-fertilized crops, the primary consideration is high-quality seed produced so as to maintain genetic purity by preventing mechanical mixture. Village seed farms are suited to this function if proper care, roguing and supervision is exercised. However, Registered and Certified seed growers scattered in many villages throughout a block prevent opportunity for competent inspections and roguing. Rarely can a VLW be trained to make satisfactory inspections or supervise roguing and make germination tests. Because of their sheer numbers and dispersion, having certified seed growers in each village rules out adequate attention from trained seed specialists.

On the other hand, producing Certified seed for the cultivators in each village has the advantage of demonstrating improved varieties and minimizing transportation costs. If a poor job is done, however, the average cultivator loses interest in renewing his seed. If the cultivator is to be expected to renew his seed when new improved

varieties are available, or in any event every 2-3 years, he must have confidence that he is obtaining seed of good quality.

Some States in India and several Asiatic countries are establishing seed multiplication schemes on a village-by-village basis. Such schemes depend on periodic waves of new Foundation and Registered seed multiplied by a leading village cultivator, and made available to saturate villages with improved varieties by natural spread. Where varieties representing a big advance in yield are involved, improved seeds will spread to a large share of the cultivators. However, this procedure places all the emphasis on *variety,* without taking into account the importance of other seed quality factors. Under the "village seed farm" plan much of the seed claimed as improved is badly mixed, untested for germination and otherwise of unsatisfactory quality. However, where properly supervised, this scheme has been very satisfactory.

Seed Farms on Medium to Larger Land Holdings

In general, where well managed, the medium to large land holdings, private or Government-owned, are best suited for the rapid multiplication of pure high quality seed of self-fertilized as well as cross-fertilized seed crops. There is no ideal size of farm. It will vary from crop to crop and area to area. In general, the larger land holders (except those who are absentee landlords) have the opportunity to set up farms which are well equipped and financed and well managed so as to obtain high yields. Contamination in the various production operations is also minimized. Thorough and timely inspection for seed certification purposes is also easier, since a large quantity of seed is involved in any one field or seed inspection.

Large land holdings are, however, not often located in close proximity to good roads and surrounding villages, particularly in rice-growing areas. Nevertheless, wherever possible, it is recommended that optimum use be made of the medium to large cultivators in multiplying Registered and Certified seed for sale to the cultivator. Several of the States are making good use of both public and private large land holdings in their improved seed schemes.

In view of the food crises, it is recommended that Registered and Certified seed multiplication effort on large irrigated land holdings be given high priority. This will result in optimum use of the limited trained personnel, fertilizer and other seed multiplication resources.

Certified Seed Multiplication Villages

In view of the slowness with which Certified seed is multiplied and spread when seed farms are in every village, and of the questionable seed quality produced under a village system, it is recommended that an effort be made to organize Certified seed multiplication at the block level on the basis of one or at the most two seed multiplication villages per block.

This would require mobilizing one village in every 10, 15 or 20 as Registered and Certified seed multiplication villages. Because seed production would then be *concentrated rather than dispersed,* such a procedure will facilitate adequate field and seed inspections for seed certification purposes. Greater and more telling effort can also be

expended in the training of village seed producers through roguing schools and demonstration in the fundamentals of pure seed multiplication.

It would be ideal if nearly all of the cultivators in the selected village can be induced to grow seed of only one variety. An alternative is dividing the land of the village between different improved varieties. A continuous land area and specified threshing floors must be allocated to specific varieties. By this means several varieties of various crops can be produced in one village.

In evolving such a village scheme, it would be necessary to provide cultivators with the necessary food grains to replace the seed removed from the village. This can be done on a barter or other suitable basis.

Special inducements to multiply Certified seed on a village basis could be made by credit arrangements, by special attention from extension workers and seed specialists, by fertilizer allocations to expedite rapid seed multiplication and loans for storing seed. Singling out one village among several for special attention by extension workers may have certain implications at the block level, yet the needs for high-quality improved seeds are so great that a concerted effort along these lines should be made.

It is recommended that the Certified seed multiplication village scheme be given high priority in the seed multiplication effort. As a start, it is urged that such a plan be concentrated in those areas of India that have the greatest opportunity for response in increased food production, i.e. surplus production or alleviating severe food shortages. Since superior organizational ability is needed to make such a plan succeed, the most competent seed specialists should be assigned to this effort. An adequate staff must be provided. As experience is gained the programme can be extended to other areas.

To assure success, it may be necessary to enact legislation sanctioning one-variety areas in villages.

Seed Testing and Seed Legislation

In India's largely self-contained village economy, there has been little opportunity for either modern seed testing or seed legislation. With respect to seed, this self-sufficient era is starting to pass. This change will require the orderly development of both seed testing and seed legislation.

Awareness of the need for seed testing is apparent in several States and the Centre where a start has been made in establishing seed testing laboratories as well as the training of seed laboratory technicians. Presently this effort has been concerned primarily with vegetable seeds and Foundation seed of the Government Seed Farms.

It is urged that each State should proceed as soon as possible with the development of seed-testing laboratories. Since seed-testing is largely a new development in India, the specifications for equipment and facilities must be obtained from those foreign countries which have well-developed seed laboratories.

Manning of the seed laboratories will require more trained seed technicians. Again it will be necessary to obtain such training from

other countries. The needed training can be accomplished by sending carefully selected mature personnel to the United States or European countries for post-graduate training as well as actual experience in seed laboratories. Seed testing cannot be learned from a book or in the classroom.

It is further urged that early attention be given to development of training in seed-testing technology in the post-graduate school of the Indian Agricultural Research Institute. This procedure would have the advantage of training the requisite number of technicians at a minimum of cost; the seeds and problems of Indian agriculture would furnish the laboratory material. Seed-testing training should also be included in specialized programmes of the State colleges of agriculture.

Inasmuch as seed of improved varieties will be of primary concern in the seed-testing procedure, it is urged that attention should be directed towards determining the genetic purity of each lot of seed. This can be accomplished by (1) classifying seed characteristics of varieties with distinguishable seeds; (2) developing a classification of seeding characteristics by 'growing out tests'; and (3) growing seed samples to full maturity in small field plots.

The increased buying and selling of seed by cooperatives and dealers, and its transport from State to State and within a State, requires the enactment of seed legislation in the respective States. Seed legislation is also needed at the Centre which would apply to seed moving in inter-State commerce and imported seed. Basically, seed legislation should require proper and accurate labelling of seed. State and Centre seed legislation should also provide for the legalized status of seed certification.

Multiplicity of Varieties—"Variety Release Committees"

Most variety listings in India include a large number of improved varieties. This would indicate vigorous plant breeding research activity. Study of research data and brief inspections of research variety testing plots, and observation of crops in the field in the Rabi season of 1958-59, prove that plant breeders have indeed developed excellent high-yielding varieties well suited to conditions in India.

Published reports, however, tend to emphasize the large number of improved varieties which have been evolved—about 300 for rice, more than 50 for wheat, about 40 for jawar, ragi 18 and gram nearly 20. India is a large country with diverse crop growing seasons per year. It is thus to be expected that two or three improved varieties for each major crop will not meet all requirements. Yet, the overwhelming number of the listed improved varieties have been evolved by selection from local (desi) and other mixed populations. It is thus likely that plant breeders using similar source material, and working in different States and at different periods, have made selections and released varieties which are very similar or closely related and sometimes identical. A careful analysis of oat breeding and seed oat programming in the U.S. of about 20 years ago revealed that for some named varieties, there were a large number of synonyms, many having been evolved as described above.

Some States report that while a long list of improved varieties is published, relatively few of these are cultivated on a large scale. This being so among the large number of varieties listed for any *one State, or group of States,* it should be expected that only a few are truly superior in yield and adaptation.

It is apparent that an inadequate variety-testing programme has thus far failed to identify the very best varieties for each State. It is therefore urged that a coordinated variety-testing programme for the important crops be inaugurated under the technical leadership and financial assistance of the Centre.

Uniform variety tests should be made up for each of the major crops on a regional basis. These tests should then be conducted throughout each region by the States and Centre. Reports on each test should be submitted to the Centre where all tests are to be compiled into a regional or all-India report. *Varieties found to be superior over a wide region should be given top priority in seed multiplication schemes.*

In the U.S. it has been found that the uniform variety tests, conducted by the States under U.S.D.A. leadership on a national and regional basis, has been very helpful in identifying the truly superior varieties with wide adaptation. This has provided a basis for concentrating improved seed production and distribution programmes on the very best varieties.

A vigorous effective improved seed multiplication and distribution programme can be conducted with a few improved varieties for each crop. An excessive number of recommended varieties dilutes the effort and leaves cultivators confused as to which varieties are the highest yielding.

It is recommended that the Centre and each State establish committees or boards officially to sanction the release and recommendation of new improved varieties. The Centre committee should be made up of scientists and appropriate administrators of the Centre with adequate representation from the States. These committees might be called "Variety Release Committees."

The Centre committee should primarily be concerned with review of breeding and variety testing programmes for the important crops. It should act in an advising and coordinating capacity. Decision on release of improved varieties developed by the Indian Agricultural Research Institute, and by other Centre Government plant breeding schemes, should be made by the Centre committee. The Centre should also make provision for recurring supplies of Breeder seed and where necessary use such methods by which Foundation seed multiplication can be launched and provided.

Leadership for the State "Variety Release Committees," should rest with the Director of Agriculture, with representatives from plant breeders, plant pathologists, agronomists, the extension wings, cultivators, and (for some crops) from industry.

Basic criteria for accepting new varieties are high yield, disease resistance, wide adaptation, responsiveness to fertilizer and water management, etc. The same criteria should apply to all varieties irrespective of origin—only the very best varieties should be included in improved seed programmes.

A committee has been established under the auspices of the Indian Council of Agricultural Research to develop a nomenclature and complete *national registry for improved crop varieties. Development and maintenance of such a registry should be expedited as rapidly as possible.* Among other information, this registry should include performance data for each variety, prescribed area of adaptation, management recommendations, a complete pedigree and a detailed variety description.

Using the Best Areas for Multiplication of Specialized Seeds

For certain improved seeds, such as hybrid maize, hybrid sorghums and vegetables, green manure and forage seeds, the most favourable area of seed multiplication should be sought out and utilized. The area where the crop is grown by cultivators is often not the best area for seed multiplication.

Certain vegetable seeds are at present produced at high elevations for good seed quality and high seed yield. It is also probable that certain areas will be found to be the most favourable for hybrid maize seed multiplication—this is particularly true of the maintenance of inbred lines and single crosses.

India's environment with its great diversity of climate, elevation and distance should be assayed for the most favoured areas of seed multiplication. Certain green manure seeds are in shortage. Forage seeds for hay and pasture production of the grasses and legumes are also in short supply and of nondescript origin. Certain areas of India can be developed as specialized forage and green manure seed producing regions to supply other areas. Transportation should not be a limiting factor since shipping seed from surplus to deficit areas is more economical than shortages or depending on uncertain foreign supplies.

2. MARKETING AND STORAGE

Improved Seed Marketing—A Major Seed Problem

Up to the present, the primary effort of the improved seed programme in India has been devoted to seed production. This is appropriate since a dependable improved seed supply must be developed before seed can be distributed to cultivators. Experience in countries with well-developed improved seed programmes indicates that seed marketing ultimately becomes a more acute problem than improved seed multiplication. Well-developed seed multiplication and certification programmes can be handled in a routine manner. Not so with successful seed marketing which continues to be dependent on many whims and inadequately understood factors.

Identification of problems of improved seed distribution or marketing on a scale to completely and continuously saturate an area with high quality improved seeds, cannot be prescribed from knowledge obtained in other countries. This is a problem which merits special study and research in India. Such a study should embody research into the average as well as progressive cultivator's knowledge regarding improved seeds.

It would be of value to know what the cultivator looks for in new improved seeds and what motivates him to have an interest in

discarding his "old" seed and to acquire new improved seeds. A seed distribution system then needs to be developed which caters to the needs and interests of the cultivator. As the knowledge and motivations of the cultivator change and become more sophisticated, it will be necessary to modify the seed distribution or merchandizing effort. This will require continuous study and adjustment to meet changing needs.

In countries with well-developed improved seed programmes, the profit motive of the producer and distributor of improved seed is a powerful force in obtaining widespread use of better seeds. This factor works equally well with cooperatives where local managers are rewarded for making a good showing in seed sales. India can, of course, not expect at present to utilize this force as effectively as many other countries. Yet the use of improved seeds by the cultivators will be in direct proportion to the merchandizing effort which is applied on behalf of improved seeds.

At present the major effort in improved seed distribution is expended by Government employees at the block and village levels. *Notable progress has been made but at present the quantity of improved seeds is far from adequate if the cultivator is to take full advantage of the currently available improved varieties and those yet to be developed by plant breeders.* It has been found that in making his indent to superior officers, the extension worker tends to take a conservative supply position. He tends to specify village needs only up to the amount of improved seed which he feels can safely be moved to the cultivators. Vigorous promotion equivalent to an all-out merchandizing effort is not practised. Under a well-conducted cooperative and private improved seed supply system, it is believed that the quantity of Certified seed distributed could be greatly increased. Necessarily an adequate credit system would need to be associated with such promotional effort.

Improved Seed Storage

In India's high temperature climate with its alternate dry and humid periods, storage of improved seeds to retain high quality is a greater problem than under more temperate climatic conditions. Storage of seeds through the hot humid part of the year is more difficult than under high temperature and low humidity. Conditions of high humidity and high temperatures can be disastrous to seed quality. Such conditions cause otherwise dry seeds to absorb moisture which encourages fungal and insect activity.

Seed stored in large quantity in Government or cooperative storage is especially subject to loss in seed quality. As additional Government and cooperative seed storage is built, it is important that adequate precaution be taken to prevent loss in viability and damage by insects and rodents. Seed storage research under tropical conditions has been conducted in other countries. Usable information as well as results from Indian seed storage investigations should be utilized to prevent seed losses. Where needed, additional seed storage research should be conducted in India.

If projected improved seed programmes materialize, great quantities of many kinds of improved seed will necessarily be stored in all

parts of the country. Improved seed storage must be provided at the village level. It is important that improved seed be within bullock-cart hauling distance of the village. Knowledge should also be accumulated on means of preventing loss in village stored seed.

Larger central seed storage will be needed at Government seed farms and where Registered seed is multiplied. It should also be normal procedure to carry a reasonable inventory of seed from year to year. A perpetual inventory of from 10 to 15 per cent of the quantity of Certified seed handled annually would be a minimum reserve. In the case of Breeder and Foundation seed, reserves must be larger.

The Need for a Seed Industry

India, with its great need for a large quantity of high quality seed of improved varieties, finds itself with no established seed multiplication and distribution industry. Although the State Governments have engaged in the multiplication and distribution of improved seeds, and some progress has been made, the future need for improved seeds is so great that additional resources to provide the Certified seeds for the cultivator must be developed. A competent seed industry is needed.

That India does not now enjoy the services of an established seed industry need not be as serious a deficiency as it may seem. It is within India's purview to develop the kind of an industry which will best serve its needs of the future. This is an unusual opportunity.

India's opportunity lies in building a seed multiplication and distribution industry geared to modern plant-breeding concepts. This ideally should be both cooperative and private, with full competition in the market place. The management personnel of an Indian seed industry would logically come from the Indian seed specialists. Such management would be in a position to mould the seed industry to fit Indian needs and problems.

It is of interest that development of seed industries of the United States and Canada for the multiplication and distribution of improved seeds has followed to a large degree the technical leadership of the research and extension workers of the State and Centre Governments. These scientists have developed the seed certification standards and procedures prevailing in the U.S. and Canada, and through research have developed the seed multiplication, processing and storage patterns utilized in the improved seed schemes.

Furthermore, the technical management of the progressive seed firms dealing in improved seeds in the U.S. and Canada are largely recruited from research and extension posts or from the post-graduate agricultural universities. It is recommended that qualified seed experts of the U.S. Land-Grant Colleges, Foundations, State Crop Improvement Associations and the seed industry could be advantageously utilized in assisting Indian scientists in a comprehensive training programme to build an Indian seed industry.

The largely self-contained agricultural village economy of India must give way to slowly increasing procurement of improved seeds from outside the village. Similarly other materials, such as chemical fertilizer, fungicides, insecticides, herbicides, simple equipment, etc., must in time also be procured from outside the villages if Indian food production is to be stepped up. It is urged that every effort be made

to amalgamate the supply function of all of these materials in service cooperatives and private dealers. It is realized that this will be a slow process though it is vital to long-range success in modernizing Indian agriculture.

If cooperatives and private dealers are to make a substantial contribution to the multiplication of improved seeds, every effort must be made to create a favourable economic climate for such operations.

The Centre and State Governments of India have assumed that State subsidy would be necessary to induce seed-growing cultivators to produce improved seeds at a price which the rank and file village cultivators would find to be satisfactory. This is a reasonable approach at the introductory stages of an improved seed programme. It is, however, desirable that the very nominal added costs of improved seeds be assumed, as soon as possible, by the cultivators as a normal crop production expense. This would reduce the cost of Government and also pave the way for cooperative and private agencies to assume the seed production and supply role. To the extent that subsidies on seed remain a necessity, schemes need to be developed which permit coöperatives and private growers to use initiative in improved seed production and merchandizing.

It is recognized that the national welfare demands that improved seed progammes be carried forward even though Government subsidy may be required to keep the programme from bogging down.

3. DATA GATHERING

In attempting any programme to increase use of improved seed, a good reporting system is essential. It is important to know within reasonable limits the proportion of the acreage of each crop which is planted to improved varieties. Such data will point out rate of progress or the lack of it, and indicate where additional effort is needed in the improved seed programmes.

But for useful reports, a definition of an improved variety is needed. If only the acreage devoted to the better varieties is reported, the figure may be vastly different than when mediocre varieties released many years ago are also included. Data on acreage planted to improved varieties should be restricted to the superior varicties that have been recommended for cultivators' use.

Reasonably accurate knowledge of the planting value of seed actually used by the cultivator would be of great help in determining the degree of progress in improved seeds at the village level.

The only sound means of determining seed quality at the village level is to collect village seeds on a statistical random sample basis. Such samples should then be tested in a well-equipped seed laboratory for the seed quality factors—such as germination, purity, weed and other crop seed content, seed-borne diseases, and, to the extent possible, varietal purity.

These samples should also be planted in small observation plots. Such plantings would serve as a method of determining the actual planting value, including varietal purity, field germination, and so on, of seed used by village cultivator.

4. WORLD SEED YEAR

The F.A.O. and cooperating countries have made plans for a world seed year to be launched for the year 1960-61. In India a Centre committee has been appointed to plan the Indian phases of this special seed effort.

Recognizing the important contribution which improved seed can make to increase crop production, it is urged that every effort be expended to make the world seed year a success in India.

5. VEGETABLE SEED PRODUCTION

Increased consumption of vegetables in the cities as well as in villages is one important way in which food supplies can be increased and the diet of the people improved. There are many problems to be resolved before India will make adequate use of vegetables in the daily diet. It is believed that inadequate supplies of a readily available assortment of kinds and varieties of vegetable seeds of good quality constitute one such deterrent..

Vegetable seeds cannot be imported in quantity from foreign countries, hence an indigenous vegetable seed industry is essential. Good progress has been made in the production of certain kinds of vegetable seeds, particularly the biennial root vegetables in Kashmir and in the Kulu Valley. In other areas, hills and plains, a start has been made in the production of a variety of vegetable seeds. Limited observations of the vegetables sold in the city markets indicate that many kinds of vegetables, often of acceptable grading and quality, are available.

Observations made in villages indicate, however, that only a limited amount of vegetables is grown. Seed for such production as does exist is obtained from the State Department of Agriculture, or by the cultivator saving seed from his garden. Vegetable seed supplies for both villagers and vegetable growers near cities are of uncertain quality and quantity.

The general problems of vegetable seeds for India have been discussed by Indian scientists and administrators (Crop and Soils Wing of the Board of Agriculture) as recently as June 1958. The analysis of problems and suggestions of these experts should be carefully considered and the necessary steps taken to remedy vegetable seed problems.

Most of the vegetable varieties grown in India are of European origin and seed was formerly imported. There is evidence that vegetable varieties, particularly those that are cross-fertilized, have deteriorated in quality. With the ban on vegetable seed imports, India is working towards development of suitable areas for vegetable seed multiplication as well as suitable methods.

The problem of maintaining a high degree of varietal purity, particularly in the cross-fertilized kinds, is particularly difficult. It is believed, however, that important genetic change in varietal purity can be prevented through a carefully planned seed increase programme. Cross-fertilized varieties are subject to varietal change either through mechanical mixture, or from foreign pollen or genetic shift when a variety is grown in a different environment than where it evolved.

Periodic importation of Breeder seed from a reliable source, followed by a limited number of generations of seed increase from such source, would be a practical method of maintaining varietal purity of cross-fertilized vegetable varieties.

In India, very little research is in progress in variety testing and breeding of vegetables. Since new superior vegetable varieties are continuously being evolved in other countries, it would appear that a programme of extensive coordinated variety testing would pay large dividends.

A start has been made in several States in the development of seed legislation and seed-testing laboratories. Yet, up to the present seed merchants are not required to indicate the variety, germination or purity on vegetable seed packets offered for sale.

The Team therefore recommends:

1. Examine vegetable varieties from other countries and as soon as possible initiate a comprehensive vegetable breeding programme.

2. Seek out and use the best vegetable seed-growing areas in India for the various kinds of vegetables.

3. Increase vegetable seed production research and development.

4. In seed multiplication schemes involving cross-fertilized vegetable varieties.

   a. Obtain from foreign sources recurring supplies of 100 per cent pure Breeder seed from the originator of the variety or other thoroughly reliable sources. Only small quantities are needed in relation to the total used in India.

   b. Multiply the Breeder seed in the most favoured areas for high seed yield and under conditions of enforced isolation and roguing so as to minimize varietal contamination.

   c. Use a minimum number of generations from Breeder seed in seed multiplication, i.e. Breeder, Foundation Registered, Certified.

5. Establish and enforce seed certification standards among the various vegetable seed-producing States. These standards should designate minimum requirements for varietal purity and other seed quality factors.

6. Work toward development of an all-India coordinated scheme of vegetable seed multiplication and distribution.

CHAPTER X (A)—THE PROMISE OF HYBRID MAIZE

Hybrid maize has an outstanding potential for increased food production. India can in 5 to 7 years make more progress in increasing maize yields than the U.S. made in 20 years. The Team feels strongly that this opportunity should be fully exploited.

After the Team had studied the problem following its arrival in India, a conference on Hybrid Maize Seed Production and Distribution was called, at the suggestion of the Team, in New Delhi on March 21, 1959. The Conference was presided over by Shri K. R. Damle, Secretary, Department of Agriculture, and was attended by Shri A. P. Jain, Minister for Food and Agriculture, and by representatives of several States—Directors of Agriculture and plant breeders; I.C.A.R.; Indian Agricultural Research Institute; and of U.S.-T.C.M., the Rockefeller Foundation and The Ford Foundation. At the Conference, background information and potentials of hybrid maize in India were presented by various specialists. General discussions followed presentation of the notes. This Conference supplied a factual basis on which recommendations in the following report are based.

1. POTENTIALS OF HYBRID MAIZE IN INDIA

Maize in India is produced on about 9,000,000 acres of land. Production is centered in 9 States that account for 95 per cent of the acreage. Average yields are only about 700 lbs. per acre.

Research on hybrid maize breeding was started in 1944-45. More recently a coordinated maize improvement scheme has been developed with several States and the IARI in cooperation with the Rockefeller Foundation. This research scheme includes the testing of exotic hybrids from other countries, the testing of exotic inbreds and single crosses as well as extensive breeding among local and exotic varieties.

Available to India is the accumulated superior maize germ-plasm from North and South America, Europe as well as Asia. It is reported that maize genetic stocks from all parts of the world can be utilized in India. *There is clear evidence that this great pool of genetic diversity when properly combined will result in unprecedented yield increase. Available here also is the accumulated knowledge and experience of maize improvement, culture and seed multiplication. These resources represents a tremendous opportunity in maize improvement. In view of India's food crisis, failure to make the most of this opportunity is a grave responsibility.*

In extensive tests conducted in India during 1950-58, the best hybrids from the southern U.S.A. out-yielded the local open-pollinated varieties by a margin of from 40 to 80 per cent. Several of these hybrids also showed the desirable characteristics of resistance to lodging, early maturity, tight husk cover, etc.

Recent tests show that Flint-dent hybrids involving a flint single cross of local lines and specific dent single crosses of exotic origin out-yielded open-pollinated varieties by 30 to 120 per cent. Consequently, an intensive search is in progress for the best combination of exotic and Indian maize germ-plasm. This holds great potential.

There is good prospect for substantial improvement over local

open-pollinated varieties in disease and insect resistance and other desirable agronomic characters as well as yield.

Hybrids with Flint or Flint-dent characteristics demanded by Indian consumers are also being developed.

An intensive and integrated research programme will be necessary to solve insect, disease, cultural and breeding problems. However, *rarely has the opportunity in any country been as great for a major break-through in increased acre-yield for an important crop as is now available to India in hybrid maize.*

Several factors should be considered in selecting a hybrid for multiplication. These are yielding ability, disease and insect resistance, desirable maturity, consumer preference, and relative ease of seed multiplication. Many hybrids can be produced to good advantage, but often the parental lines are very difficult to propagate under extreme conditions of weather existing in India.

Maize is one of nature's most efficient converters of sunlight, nutrients and water into human food. *The yield of maize in India can easily be increased by 100 per cent by the use of hybrids with increasing supplies of fertilizer, water for irrigation, drainage, and plant protection measures.* With better farming practices and the willingness of the cultivators to change, both yield and acreages planted to maize should increase sharply.

2. INITIATING HYBRID MAIZE SEED MULTIPLICATION

For the past several years individuals and State Agriculture Departments in Punjab, Uttar Pradesh and Jammu and Kashmir have separately and in cooperation with T.C.M. engaged in limited multiplication of hybrid maize seed. This early effort has met with success in most instances. The experience gained to date will be of great value in bringing about the needed rapid expansion of hybrid maize seed multiplication.

Since fairly well-adapted exotic hybrids, with more than 40 per cent potential yield superiority over open-pollinated varieties, are now available, it is recommended that resources be immediately mobilized to bring about a rapid increase in the production of hybrid maize seed in India. Until such time as a coordinated scheme is put into being, it is recommended that resources now available be utilized. In a short period of time (up to 2 years), better locally bred hybrids will be available and in the meantime valuable experience is being gained in solving future seed multiplication problems.

3. THE NEED FOR A COORDINATED MAIZE SEED PROGRAMME

Seed Stocks

Hybrid maize seed multiplication is unique in that success of the programme is dependent, among other needs, on a regular recurring supply of high quality inbred and single cross seed.

It has been estimated that for each 1,000 acres planted to hybrid maize on cultivators' fields, 200 maunds of double cross seed is required. This quality of double cross seed can be produced only if 200 pounds of single cross seed had been produced the previous season. The 200

pounds of single cross seed is in turn dependent upon 1 acre of inbred line production.

Thus it may be seen that the production of enough hybrid seed for 1,000 acres of cultivators' fields is dependent upon the uninterrupted success of stock seed production for 3 seasons in succession. Bearing in mind that there are 4 inbred and 2 single crosses in each hybrid, it is apparent that planning and coordination are necessary in seed stock maintenance.

Inbreds form the base of hybrid seed sold to the farmer. These inbreds by their very nature lack vigour and are low-yielding. Thus to assure adequate supplies and provide for contingencies, seed must be produced in abundance and in the most favoured areas, and an adequate reserve supply must be maintained. Often an inbred or a single cross will be used as a parent in several hybrids which may be recommended in different States. Bearing in mind the overall problems of seed stock for hybrid maize, *it is recommended that this vital activity be coordinated on an all-India basis, to enable the Seed Stocks Organization to produce and utilize seed most efficiently.*

Producing the Double Cross Seed

Seed schemes currently in operation in most States for rice, wheat, millet, cotton, etc., are unsuited to hybrid maize. Therefore a new scheme must be evolved.

In order to produce hybrid maize seed successfully, several factors must be considered and a satisfactory solutions found for all of the problems involved. These factors are land, financing, trained personnel, specialized equipment, seed stocks, and planned production schedules. The latter in particular, and the others in general, positively indicate the need for a coordinated effort by the various cooperating agencies and the Central Government.

As to land requirements, it is recommended that priority be given in seed multiplication to the larger land tracts either owned by the State and Centre Governments or by individuals. High priority should also be given to expansion of hybrid maize seed acreage on "garden colonies" where an entire village produces seed of one hybrid. The use of the proper male single cross for limited acreages would be an aid in obtaining needed isolation.

Hybrid maize seed multiplication must be conceived in terms of large quantities, considerable capital and a high degree of specialization. For example, to convert the 1¼ million acres of local varieties to hybrid maize in the State of Punjab alone will require an estimated 182,260 maunds of seed or an annual seed production area of between 15,000 and 20,000 acres. Six times this amount would be necessary to saturate the area presently devoted to maize in India as a whole. In view of the great scarcity of specialists trained in hybrid maize seed production, this job for Punjab as well as other States cannot be done except on a highly organized, centralized basis. Land holdings of sufficient size must be available to assure adequate isolation and timely certification ispections.

Successful seed production can only be achieved by producing sufficient volume of high quality seed to make programmes profitable to the producers and the cultivators.

In the multiplication and distribution of hybrid maize seed, it may be possible to organize certain villages to produce the hybrid seed used locally in surrounding villages. In such a scheme the Foundation single cross seed should be supplied from a suitable source such as the State or Centre hybrid maize scheme. To obtain needed isolation, all of the maize in the selected village must be planted to only one hybrid intended for seed multiplication. As an additional isolation precaution, it may be necessary to supply single cross seed of the male seed parent to corn-producing villagers who are not engaged in the hybrid maize seed project. Expert advice, supervision and inspection will be required in all phases of the project including planting, detasselling, harvesting and drying.

In the coordinated hybrid maize scheme, sufficient capital financing must be available to (1) install adequate forced heated air seed corn dryers for the planned production in each major location, and (2) provide suitable cleaning, grading, and seed treatment equipment, and (3) controlled temperature and humidity storage for Foundation seed.

Operating capital is needed for (1) personnel—both permanent trained staff and day labourers, (2) payment for the contracted seed at delivery, (3) production costs of Foundation single cross seed and inbreds, plus a safe inventory carried from year to year.

Achieving a Coordinated Hybrid Maize Seed Programme

The need has been cited for a coordinated programme on seed stocks, bearing in mind that frequently an area with favoured soil and climate in one State may produce seed stock for another. In some States, maize is produced in both Kharif and Rabi seasons. It is also likely that certain States can advantageously produce double cross seed for other States.

Financing of considerable magnitude, both capital investment and operating funds, is also necessary, as is a high degree of competence and efficiency in overall and detailed operations.

In view of the magnitude and nature of the hybrid maize seed problem, it is recommended *that an all-India fully coordinated hybrid maize seed multiplication scheme be developed and put into immediate operation.*

This should be an organization operating from the Centre under Centre charter, with branches operating in the respective States under State charter. Double cross maize seed multiplication should remain the primary responsibility of the several States; the States thus need freedom of action to develop adequate State programmes.

It is believed that the needed coordination, planning, financing and State flexibility can be attained under an autonomous corporation or cooperative set up at the Centre with member branches in the States. Financing of operations in the Centre and in the States should come from the Centre, to the extent needed.

Policy for the coordinated phases of the scheme would be developed by a "Board of Control." Membership on such a Board should be composed of the Director of Agriculture (or his representative) of the cooperating States, and the Manager of the Hybrid Maize Seed Production Branch for the States, a representative of each of the various

State Maize Seed Growers' Association, Centre technical officers with knowledge and experience with maize and a representative from the financing agency. The Committee now being established by I.C.A.R. for the development of maize production can logically serve as a nucleus for centre representation on the Board. Experts from U.S. T.C.M., the Rockefeller Foundation and other experts should act as ex-officio advisers.

It would be expected that there be a State-level Board of Control to guide State operations under overall policies established by the Centre coordinating Board.

Functions of the Coordinating Board of Control

(1) The Board should be empowered to plan, finance and execute a forward-looking hybrid maize scheme for India. This should include assuring the production, or if need be the purchase, from available (including foreign) sources, of high quality inbreds and single cross seed needed in the planned production programme. Seed stock acquisition and maintenance should be a Board function. Refrigerated storage must be provided to maintain viability of seed stocks over a period of years.

(2) The Board should approve financing of the Branches in the States, based on State requests, backed by an adequate operational plan, and a guarantee that a competent technical staff is available.

(3) The Board should determine, in consultation with the State Branches and the State Departments of Agriculture, and on the basis of acceptable criteria, which hybrids and seed stocks shall be included in the Foundation seed stocks schemes to serve the individual State Seed Schemes. To minimize seed stock maintenance problems, hybrids adapted to a wide area should be selected for production in the seed stocks scheme. The individual States should, however, be free to include hybrids which have particular usefulness in their respective areas.

The individual State branches of the coordinated hybrid maize scheme should be responsible for the coordination of hybrid maize production, storage and distribution within each of the States. The State Branch should work closely with the State department of agriculture, research and extension wings, with Community Development, cooperatives and grower associations, in planning and executing the maize programme in each State. The programme should include plans for education and for achieving seed distribution.

The quantity of seed contracted for in the individual States should be based on the combined judgment of State agencies concerned. Furthermore, it is important that the appropriate State agency or agencies be in position to assume possession of the seed financed by the Centre in ample time to bring about a vigorous seed distribution programme.

The Need for Autonomy

The usual State or Centre Government departments are not suited to achieving the objectives of a successful hybrid maize seed multiplication programme. Rigid fiscal policies, normal government

budgeting and lack of flexibility in the usual government operations would hamper the need for quick action and adjustment to unpredictable weather conditions and changed supply situations. Some of these contingencies may include the on-the-spot need to modify drastically the acreage to be planted, for sudden plant protection measures, purchase of seed stocks from foreign countries or movement of such stocks from one State to another.

Hybrid maize seed production is highly specialized. Therefore, autonomy is needed by the Centre and States on personnel policies. This includes recruitment, advancement and disciplinary action. For success, competence and results must be guiding factors in personnel management rather than seniority or other considerations.

As to management personnel, it is recommended that there be a hybrid maize seed production manager in each participating State and, for seed stocks, one at the Centre. The manager should be held strictly responsible under acceptable accounting procedure. Primary criteria for management reward should be results—the quantity and quality of hybrid maize seed efficiently produced, processed and distributed.

The selection of managers should be done by the respective Centre and States "Boards of Control." Government servants, if selected, should be permitted to join their posts on a detached service under conditions which safeguard their retirement and other perquisites.

Recommendations as a Guide Line

The recommendations made above under the heading "Achieving a Coordinated Hybrid Maize Seed Programme" are intended to reflect the Team's recommendations based largely on the consensus of opinion of the Maize Seed Conference held in March. Only general guide lines are suggested. Details of the nature and structure of the coordinated scheme can be quickly worked out once the principle of an autonomous coordinated scheme is accepted.

With the knowledge and experience at hand in India, and with additional technical resources available from other countries, it is our conviction that a successful vigorous hybrid maize seed programme can be effectuated. *It is urged that all technical resources be mobilized—these include Indian maize breeders and maize seed trainees; U.S. T.C.M. (including the contract Land Grant Colleges in India), the Rockefeller Foundation, plus additional technical and organizational skill as needed.*

Overtures have been made by Indian officials in cooperation with T.C.M. to encourage hybrid maize seed firms of the U.S. to undertake an Indian maize seed programme. Thus far such overtures have not materialized and prospects do not appear to be bright at the moment. The time is past when negotiation is in order. We wish to reiterate that with proper mobilization of the resources available to India, India can get the job done.

4. SEED CERTIFICATION AND SEED LEGISLATION

The production of high quality hybrid maize seed requires a high degree of competence and integrity. To assure a uniformly high quality for all inbred, single cross and double cross seed, it is essential

that all seed be produced under uniform minimum seed certification standards. The F.A.O. has adopted hybrid maize seed certification standards from those prevailing in the U.S. It is recommended that India study these standards and consider their adoption by the States producing hybrid maize seed.

Seed legislation, as noted earlier, is necessary for several seed crops in India, but is particularly vital in hybrid maize seed. Certified inbred, single cross and double cross seed will be produced in several States and by many producers. A large number of officers and individuals will be involved in various production, processing and handling phases. Also, various classes of seed will move from State to State either under Government, cooperative or private auspices.

Under the proposed corporate structure, to provide the production and processing phases, it is essential that adequate quality control—i.e. certifications measures—be taken by the State Departments of Agriculture. The inspection and certification of hybrid maize seed should be under the direct control of the State Departments of Agriculture. The legal basis for certification and other legislation needs should be provided for by a Seed Act in each State. It is recommended that the hybrid maize seed certification fit into the same organizational set-up being proposed in this chapter for other seed crops.

With respect to provision for adequate isolation, it is also recommended that the State be provided with the needed sanctions. A model State Seed Law should be drawn up and submitted to the States concerned for appropriate enactment.

All lots of seed—inbreds, single and double crosses—should be officially sampled and planted in growing-out observation tests. Such tests should serve as a check on genetic identity, isolation, proper detasselling, admixture and field germination.

It is believed that the State Branches of the coordinated scheme should contract or arrange for the needed seed production. Certification should be handled by a State Department of Agriculture staff accountable to the Director.

5. TRAINING HYBRID MAIZE SEED SPECIALISTS

A good start has been made by cooperative effort of the Indian State and Centre Governments with U.S. T.C.M. and the Rockefeller Foundation, in training of a cadre of maize seed specialists. This involves training in maize breeding as well as seed production. The training of individuals includes :

(1) experience in States which now have production programmes supervised by U.S. T.C.M. technicians;

(2) experience under the India-Rockefeller coordinated breeding and pilot seed programmes; and

(3) experience under U.S. T.C.M.-sponsored training in the U.S.A.

Wherever needed, the training programme should be intensified and the requisite personnel, Indian and foreign, should be mobilized. Once men are trained and their competence demonstrated, it is highly essential that such personnel be given ample opportunity for employment, and kept on the hybrid maize seed production programme.

6. THE HYBRID MAIZE EDUCATIONAL PROGRAMME

Research and demonstration work with hybrid maize has amply demonstrated that the high genetic potential of hybrid vigour can be realized only when good cultural practices are used in combination with hybrid seed. The demonstration technique is a proven teaching device in India. It is, therefore, important that a large number of successful multi-factor maize demonstrations be established in the current and potential maize-growing areas in India. These demonstrations should include seed, fertilizer, plant protection, wise choice of soil type and water management, including good drainage.

It is highly probable that hybrid maize can help extend maize production to areas and under conditions where maize is now not produced. Development research and demonstration should be fully utilized, sometimes along unorthodox lines, in extending the potentials of hybrid maize.

To fully utilize the potentials in maize, the eating habits of many people will in all probability need to be changed. This too will require demonstration and education.

7. A LONG-RANGE PROGRAMME

A well-conceived and competently managed hybrid maize seed programme can be successful financially. Provision should, therefore, be made for repayment of capital and operational financing. As the programme grows, it is conceivable that State "Branches" may be able to assume the financial responsibility of double cross maize seed and seed production. In turn State seed growers' associations and individual growers may also be able to assume added initiative in seed production and sales. Plans should be made at the outset for turning over to the States the double cross seed multiplication operations and management, and for the Centre Board to become primarily a seed stocks organization serving the various States.

8. HYBRID MAIZE SEED DISTRIBUTION

Seed distribution patterns and practices recommended in the preceding detailed chapter on improved seed multiplication and distribution should be applicable to hybrid maize. It is urged that every effort be made to encourage cooperative and private seed distribution of hybrid maize seed. New seed must be purchased each year to get maximum returns from hybrid. Thus vigorous merchandizing effort is needed.

9. HYBRID SORGHUM

A vigorous coordinated hybrid sorghum improvement programme has been launched. When sorghum hybrids are available, it is believed that practices suggested for hybrid maize are equally applicable to hybrid sorghum.

CHAPTER XI. LIVESTOCK DEVELOPMENT AND FOOD PRODUCTION

Cattle will have an indispensable role in programmes for increasing food production. They will provide the power for farm operations and for transporting agricultural products to market. To the extent that milk yields are increased, cows and buffaloes will contribute directly to the attainment of "food enough." Development of poultry can make an immediate and substantial contribution to greater food production. Sheep, goats and pigs are also potentialities, although only on a long-term basis.

Thus, in mobilizing resources to increase food production, the efficiency with which animals provide motive power and produce food for humans becomes a matter of primary importance. For animals use land and other resources which could be used in producing foodgrain and fibres urgently needed by human beings.

The problem, then, becomes one of minimizing competition between people and animals for products of the land. The objective clearly should be to improve the efficiency of motive power and to increase the quantity of animal products without using more land; or, better still, to produce more power and more animal products from less land than is now being used for these purposes. In any event, the contribution to increased food production can be made only by means of programmes which are based upon sound economic principles and scientific findings.

India has the technical competence and the animal and other resources necessary to achieve this objective. The overriding question is whether these resources will be mobilized in such a way as to produce the desired results. Unless the resources are used where they will really count, i.e., in the villages on projects which will result in better feeding, management, breeding and marketing, contributions to increased food production will be of little consequence. *It is not enough to conduct systematic work in animal husbandry on Government livestock farms. The real test is what happens in the villages and on the land.*

Too Many Cattle:

There is widespread recognition, not only among animal husbandry officials and technicians but among citizens generally, that India's cattle population is far in excess of the available supplies of fodder and feed. The bovine population of India is estimated to be 203 millions, of which 155 millions are cattle and 48 millions buffaloes. This is one-fourth of the world's total bovine population, and more than that of any other country. Only Denmark has more cattle per square mile than India.

At least one-third, and perhaps as many as one-half, of India's cattle population may be regarded as surplus in relation to the feed supply. The problem is being accentuated greatly by a steady annual increase in cattle numbers. It is this situation which doubtless was responsible for the following statements being included in the Second Five Year Plan:

"Large numbers lead to poor feeding and poor feeding comes in

the way of attempts to raise productivity. There is thus a vicious circle which it is difficult to break."

"At present only a fraction of the contribution which animal husbandry and dairying can make to the growth of the rural economy and a rise in living standards is being realized."

There is manifestly only one way to break this "vicious circle," and that is by the vigorous implementation of a positive programme to bring the number of cattle and the supplies of fodder and feed into balance. This objective, in turn, can be attained only by accepting the validity of these propositions:

1) The number of cattle must be reduced.
2) The production of fodder and other feeds for cattle must be increased.

Reducing Cattle Numbers

That a comprehensive programme for reducing the number of cattle, regulated by Government, would be the quickest and most effective way to bring cattle numbers and supplies of fodder and feed into balance, is generally recognized, even by many who would oppose such a programme for reasons of sentiment. In this connection, it should be noted that Article 48 of the Constitution of the Government of India reads as follows:

"The State should endeavour to organize agriculture and animal husbandry on modern and scientific lines and shall, in particular, take steps for preserving and improving the breeds, and prohibiting slaughter, of cows and calves and other milch and draught cattle."

The Attorney General of the Government of India has ruled that it is not within the legislative competence of the Central Government to legislate with respect to cattle slaughter. Instead, this is a matter which is solely within the jurisdiction of the several State Governments.

Pertinent statements relative to this question were made by Prime Minister Nehru[1] on February 21, 1955, in his discussion of the Indian cattle preservation bill. This bill provided for a complete ban on all cattle slaughter. Mr. Nehru, among other things, stated:

"I wish to make it perfectly clear at the outset that the Government of India are entirely opposed to this bill and would ask that this House reject it completely and absolutely. I say so for two or three principal reasons, one being that so far as our legal advisers are concerned, as the House knows, they have advised us that it is not right or competent for this House to deal with this matter in this way....According to the Attorney General this is a matter for the State Governments to consider. Well and good. My advice to the State Governments must also be not to consider such a bill and not to proceed with it....

"I cannot accept that animals are more important than economics and I think human beings are more important than cows. I do not agree and I am prepared to resign from Prime Ministership but I will not give in to this kind of....I want to be perfectly clear about it that this kind of agitation in India is futile, silly, ridiculous and I want to emphasize this is the position of the Government and the policy of

1 Lok Sabha Debates, Vol. III, No. 31, 2nd April, 1955. Lok Sabha Secretariat, New Delhi.

the Government is perfectly clear on this. We stand or fall on this and do not give in because of agitation of this kind on this point. We shall have constructive measures. We shall apply those and we are not going to compromise on this issue because this is an issue of vital consequence, the cattle wealth of this country.

"My advice to some people who do not understand the economics of agriculture is not to take a step which will ruin our cattle wealth and do something which has often important constitutional consequences and it is not possible."

It may be noted that Mr. Nehru's opposition to this bill was upheld by a 95 to 12 vote of the Lok Sabha.

On an earlier occasion Mr. Nehru had demonstrated his understanding of the cattle situation in India by saying[2]: "It is an irony of fate that although the cattle are worshipped in this country yet our animals are both neglected and ill-fed."

Nor do technical personnel, who are concerned with the problem, hesitate to express their opposition to the ban on slaughter. For example, a committee appointed in 1954 to study the question concluded by saying[3]:

"After careful consideration the Committee have come to the conclusion that a total ban on slaughter of all cattle would not be in the best interests of the country as it is merely a negative and not a positive approach to the problem...."

Opposition to the ban on cattle slaughter also was voiced in the following resolution adopted by a vote of 89 to 6 in 1957 by members of the Animal Husbandry Wing of the Board of Agriculture and Animal Husbandry in India:[4]

"The ban imposed on the slaughter of cattle in the various States should be immediately lifted."

This changing trend in the attitude toward cattle slaughter also was revealed in the results of a questionnaire[5] circulated by the Indian Council of Agricultural Research to agriculturists and human nutrition specialists across India. Of those who replied, 46 per cent believed there was no alternative expedient for the elimination of useless cattle (i.e. cattle which produce neither milk nor work) other than by planned slaughter. Thirteen per cent believed in planned slaughter but (like the 23 per cent who regarded cattle slaughter as repugnant) felt that gosadans should be given a trial. Of the remainder, some recommended the export of useless cattle, while others, though they recognized the problem, did not indicate how it could be solved.

The ban on cattle slaughter has resulted in large numbers of stray cattle, which not only are responsible for the imbalance of cattle

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2 Nehru, Jawaharlal. Speech at the Distribution of Prizes, All-India Cattle Show, New Delhi, 25th February 1948.

3 Ministry of Food and Agriculture, Government of India, Report of the Expert Committee on the Prevention of Slaughter of Cattle in India. Government of India Press, New Delhi, 1955.

4 Proceedings of the twelfth meeting of the Animal Husbandry Wing of the Board of Agriculture and Animal Husbandry in India, Mimeographed, 1957.

5 Whyte, R. D. The Grassland and Fodder Resources of India. The Indian Council of Agricultural Research, New Delhi, 1957.

numbers and feed supplies, but are a serious menace to crop production. The problem is recognized by citizens generally and is a subject for comment in newspapers as well as in technical reports and publications on animal husbandry. A recent editorial[6] contained the following pertinent observations :

"The alarming increase of stray and wild cattle over wide areas of northern India is fast becoming a major disincentive to crop cultivation....Occasional reports coming from various States of official efforts to grapple with the problem do not give an accurate picture of the seriousness of the situation.... Popular sentiment against cow slaughter no doubt lies at the back of the problem. People prefer to let their aged, diseased and otherwise useless cattle live at the expense of other people's crops....Surely, here is a matter which calls for serious re-thinking on the part of both the orthodox public and the States and the Central Government."

Modifications of the ban on cattle slaughter by the States so as to permit the economic utilization of stray and useless cattle would contribute significantly to the attainment of the objective for animal husbandry programmes set forth in the Second Five Year Plan: "...to increase the supply of milk, meat and eggs, a greater consumption of which is very essential in order to balance the present customary diets, and to provide efficient bullock power for agricultural operations in every part of the country."

Authentic figures are not available upon which to base a reliable estimate of the losses to the nation because of unproductive cattle. Monetary losses unquestionably are very large. Research is needed to determine what these losses are. Information thus obtained should be used in educational campaigns to correct the imbalance between number of cattle and supplies of fodder and feed.

Some idea of the magnitude of the loss to the nation from feeding useless cattle and buffaloes may be gained by calculating the quantity of milk that would be produced if the feed now being consumed by such animals were added to the rations of milch animals whose maintenance requirements are already being provided for. (In this connection, it should be kept in mind that more dung is produced when a given quantity of feed is consumed by one animal than when it is shared by two animals.) If this transfer of feed were possible, it would seem reasonable to assume that at least one additional pound of milk per day would be produced as a result of eliminating one useless animal.

Thus, for each animal eliminated, 365 pounds of milk would be gained annually. This quantity of milk, if valued at 13 annas per seer, the price now being paid at many points in India, would be worth Rs. 148. *On this basis, the total amount gained annually by the nation from eliminating useless cattle and buffaloes would exceed Rs. 70 crores.* Of perhaps even greater significance than the monetary gain is the fact that each pound of additional milk thus made available would provide the suggested daily allowance for one Indian child.

Unless problems associated with excessive cattle numbers and the attendant shortage of feed supplies are dealt with realistically,

6 Roaming Cattle. Editorial, *The Indian Express*, New Delhi, 27th February, 1959.

contributions of animal husbandry to increased food production will be extremely difficult, perhaps impossible. To a Westerner, a realistic approch to the solution of these problems would have to include a cattle slaughter programme. Yet one who accepts an assignment to advise India on such matters must keep the doctrine of ahimsa* in mind and be prepared to analyze problems within the limitations of that doctrine. Unless he is prepared to do this, it perhaps would be better that he does not accept the assignment.

Schneider[7] has commented on an instance which illustrates how difficult it is for a Westerner to adapt his thinking to this doctrine. According to Schneider "one world authority on livestock breeding told me that he had refused a position in India because he understood that people would not kill their inferior animals. Thus he could do little professionally, and it would be useless for him to go there. Even among leading Hindus, one can recognize a note of hopelessness with regard to cattle improvement. Although they may be committed to the doctrine of not killing cattle, nevertheless with their background of education in Western practices in animal husbandry, they cannot conceal their conviction that the task of breeding improved cattle in a Hindu society is impossible."

Though he recognized the difficulties associated with a ban on cattle slaughter, Schneider believed that progress could be made within the limitations imposed by the doctrine of ahimsa.

This report and the recommendations contained herein also have been prepared with a similar belief, along with a deep sense of obligation to point out how the ban on cattle slaughter complicates the problem of increasing food production. Furthermore, a study of food production in India manifestly would be incomplete without some consideration of the cattle slaughter question. *This should not be taken to mean that it is necessary for outsiders making such a study to take a position for or against cattle slaughter in India. The question is one which can be dealt with by India alone under her own political and socio-religious systems.*

Zinkin's comments[8] on the dilemma faced by Westerners in situations like this seem particularly apropos at this point in this discussion. He wrote:

"In dealing with other societies, one should pay them the compliment assuming that they will not change their beliefs for reasons less strong than those for which the critic would change his own. This the politician knows, the economists far too frequently ignores. If a Hindu believes that killing cows is a sin so profound that it will cause him to be reborn in the next life as an animal, it is irrelevant to point out, as the economist so often does, that a cow which is too old for milking eats but gives no return: the argument is as much a waste of time as telling an English suburban housewife that she should have her dog put down because the meat he eats worsens Britain's balance of payments. If one wished to change the Hindu attitude to cows, the only

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* Ahimsa is that part of Hindu philosophy which prohibits the killing of any animal life.

7 Schneider, Burch H. The Doctrine of Ahimsa and Cattle Breeding in India. *The Allahabad Farmer*, Vol. XXIII, No. 2, March 1949.

8 Zinkin, Maurice. Development for Free Asia. Issued under the auspices of the Institute of Pacific Relations. Collins Paper Books Ltd., London, 1956.

effective way is for the politicians to argue that the Vedas do not in fact require such respect for cows, and that it is a subsequent accretion which can permissibly be sloughed off again. Whether this is correct or not it is not for a non-Hindu to say; but it is obviously the best line of attack."

Guide lines for dealing with such questions also have been suggested by Panikkar in his book "Hindu Society at Crossroads".[9] He emphasizes that "...the impact of science on Hindu customs and practices has been of a far-reaching character and will be more so when scientific knowledge penetrates the masses." The argument of his book is that "...the translation of the idea of the community from the realm of the mind to the realm of activity through the modification of laws has now been rendered possible both by the awakening of the Hindu mind and by the existence of effective machinery of legislation entitled to general obedience and capable of enforcing it.... The legislation that can remodel Hindu society should aim not merely at correcting evils or changing customs that have become obsolete, as in the past, but at the consolidation of the progress of the Hindu mind in terms of law.... A legislating state and a static society cannot exist side by side."

It is of interest, also, to note that science, according to Panikkar, has demolished faith in many practices, customs and ancient beliefs. He states that the practice of vegetarianism is in no way connected with Hindu religion "but is followed by higher castes as a part of religious custom," and ceases to have meaning when considered scientifically.

Other Means of Reducing Cattle Numbers

While an outsider may properly conclude that he should leave the question of cattle slaughter for India's political and professional leaders to deal with, he also may just as appropriately feel that it is within his province, when his advice on animal husbandry is requested, to recommend other means of reducing the number of cattle and of controlling the rate of reproduction. *With this in mind, the following practices and procedures are recommended:*

(1) *A tax on cattle.* Tax exemptions on bullocks required for farm work and on the number of breeding cows justified by the size of holding could be authorized. A graduated tax schedule for animals, with such suitable exemptions, would help to bring cattle numbers in balance with feed supplies by making the maintenance of such animals a financial burden on their owners. Cattle for which people take responsibility should be identified by appropriate means; and all animals not identified by the village should be declared outlaws. *All taxes collected on cattle should go to the panchayat for agricultural development.*

(2) *Compulsory confinement of all bulls kept for natural service.*

(3) *Mandatory castration of all young bulls not required for breeding.* The operation should be performed before the bulls become of serviceable age.

(4) *Compulsory sterilization of surplus cows and heifers.*

9 Panikkar, K. M. Hindu Society at Crossroads. Asia Publishing House, New Delhi, 1955.

(5) *The advisability of enacting a law prohibiting open grazing should be investigated. In any event, an educational campaign to eliminate open grazing should be undertaken so that regeneration of grasslands may be accomplished.* Compulsion to keep animals within the farm premises would help to control cattle numbers.

Dessicating Plants

It has been estimated that about 2.5 crores of carcasses of fallen animals are available in India each year.[10] Less than one-half of the value of the by-products from these carcasses is being realized. Steps should be taken immediately to stop this enormous wastage. *It is recommended that dessicating plants be established on a sub-district, district or regional basis. These plants should be equipped to salvage hides and fats and to produce meat meal, bone, and animal by-product fertilizer.*

An essential feature of the project should be adequate payments, not only as reimbursement for carcasses, but also as compensation to those who bring them to the dessicating plant or who notify plant officials of the availability of fallen animals which have been identified by the village, and to whoever collects cattle not appropriately identified.

An excellent appraisal of the situation with respect to the utilization of animal carcasses has been made by the Indian Council of Agricultural Research. Implementation of the suggestions made in this I.C.A.R. publication might well be extended to include tanning of hides, and, in some instances, to the production of leather goods as a small industry project where the carcasses are processed.

Production and Use of Fodder and Feed

Increasing the production of fodder and other feeds presents almost as many problems as are encountered in reducing the number of cattle. Many suggestions and recommendations for producing more and better feed are in the literature; yet Indian cattle and other farm animals are still the poorest fed and the least productive of any in the world.

It is recommended that forage research be increased, particularly to identify and develop varieties suitable (a) *for intensive production in small areas and* (b) *for use in rotations. Initially, such programmes should stress the testing of existing varieties.*

A clear-cut statement of animal husbandry objectives is urgently needed. This statement should be concerned with the production and use of fodder and feed as well as livestock improvement and marketing. Thus far, Five-Year Plans contain only isolated items dealing with animal husbandry development.

Integration of Livestock Production and Crop Production

There is a tendency for various government workers who are concerned with feeds and feeding, with management, breeding and marketing of farm animals, and with processing and marketing of

10 Hock, F. H., and Haq, Noorul. How to Utilize Carcasses. Farm Bulletin No. 47, Indian Council of Agricultural Research, New Delhi, July 1958.

animal products, to work alone, not as members of a team striving to attain a common objective. Policies and procedures for work in all these areas should be coordinated. *There should be one programme for animal husbandry irrespective of where the work is done or who does it.* In other words, technical personnel in agriculture, animal husbandry, community development, cooperation and allied subjects should thoroughly understand that *livestock production and crop production are not separate entities, but are interdependent and must be managed together.*

The Indian Council of Agricultural Research coordinates agriculture and animal husbandry through the Board of Agriculture and Animal Husbandry. *It should be possible to evolve a plan for formulating and executing projects which would ensure effective coordination and teamwork between the two Wings of Agriculture, i.e., Crops and Soils and Animal Husbandry. Such efforts* should include grassland management, and crop-planning programmes which will introduce fodder crops in suitable rotations, encourage the growing of more fodder, and promote forage testing and breeding projects on cattle breeding farms and other experiment stations.

It is particularly important that planning and coordination should include grasslands and their management. The urgent need to do so is strongly implied in this challenging statement made by Whyte and Kumar:[11]

"Little in the way of grassland improvement can be achieved until India...takes constructive action to break the vicious circle of excessive numbers of degenerate cattle, degraded grasslands, and the general deterioration of land and the animal industry on which the whole structure of agriculture depends."

The Board of Agriculture and Animal Husbandry will need the counsel and assistance of lawyers and specialists in soil conservation and other fields, when studying problems of grazing control and preparing the way for laws that require licensing of grazing on all public lands under management systems that permit adequate protection of soil and plants.

A uniform policy to be followed by technical personnel in agriculture, animal husbandry, community development, cooperation and extension should be developed. This policy should stress the interrelationship of crop production and animal husbandry. Special emphasis should be given to systems of mixed farming adapted to the needs of the individual cultivator. Feeding, management, breeding and marketing must be integral parts of a *unified action* programme, with the objectives clearly stated in terms of results to be attained in the village.

It should be realized that Government farms and other institutions for research and/or development are only means of attaining this goal, not ends in themselves. Their results can only be evaluated in terms of accomplishments in the villages and on the land.

This approach means that veterinarians, who have responsibility for all phases of animal husbandry, must share their responsibility with

11 Whyte, R. O., and Kumar, L. S. Grassland and Its Management. Farm Bulletin No. 31, The Indian Council of Agricultural Research, New Delhi, 1957.

technical personnel in other fields. Failure to do so in the past has meant that attention given to and results achieved from feeding and other phases of animal husbandry have not been commensurate with those of disease control and artificial insemination.

The All-India Key Village Scheme[12] was planned as a co-ordinated programme which would bring about improvement in feeding, management, breeding and marketing. In practice, however, this integrated approach was ignored or at least neglected. As a result, practically the only tangible evidence that the Key Village Scheme was undertaken has been the calves produced by artificial insemination. Beneficial possibilities of this phase of the scheme have been largely eliminated, however, because of failure to improve feeding practices.

Mixed Farming

Mixed farming in India[13] is a cropping system which is designed to ensure the production of not only cereals but also of fodder, vegetables and cash crops. It also includes the utilization of animal manure and hence helps to ease the shortage of commercial fertilizers.

The development of agriculture on mixed farming lines seems to be the most rational pattern for agricultural development in India. New areas brought under irrigation should be used as pilot projects to demonstrate the advantages of mixed farming and the practices and procedures required for success. Special emphasis could be given to the integration of animal husbandry and farming. Thus, these projects would be of inestimable value in developing an understanding among technical personnel and administrators in agriculture, animal husbandry, community development and allied subjects of the interdependence of livestock production and crop production.

Objectives of the *unified action programme* mentioned earlier in this report are the same as those for mixed farming. Resources for the attainment of these objectives should be concentrated in a few key villages. There should be an all-out effort to produce results in all phases of the programme for use as demonstrations to other villages.

Once the objectives, plan of work and budget have been approved, those having responsibility for implementing the programme should be given authority to act. Also, coordination of all elements in the programme relating to agriculture and animal husbandry must be insisted upon at the village level.

Mixed farming should be linked to a country-wide marketing organization, which will relieve the farmer of major marketing problems. Efficient marketing arrangements, which will ensure the farmer a full share of the profits of animal husbandry, constitute the crux of the problem of livestock development.

There should be an active live organization in the village promoting the interests of the farmer. This organization should pay the same meticulous attention to all details of production as is given at the city end, as, for example, in the processing and distribution of milk in cities.

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12 A Handbook of the Key Village Scheme for Cattle Improvement in India. Ministry of Food and Agriculture, Government of India, New Delhi, 1954.

13 Singh, D. N. Mixed Farming in India. Farm Bulletin No. 40, Indian Council of Agricultural Research, New Delhi, November 1957.

Cattle Breeding and Dairy Development

Increased consumer purchasing power may be expected as a result of economic development and industrialization of the country. These advances along with more widespread appreciation of the value of milk as a source of protein will bring an expanding market for milk and dairy products in cities and towns. Food production goals should take this potential into account, for low protein consumption per capita is reflected in the health of the nation. A substantial increase in milk production, therefore, would be desirable.

Improvement in the draft and milk producing ability of cattle and buffaloes is the objective of artificial insemination units and livestock development farms. If this objective is to be attained these hurdles must be overcome: (a) improper and inadequate feeding of the calves produced by artificial insemination and (b) lack of an adequate plan for the proving of sires.

Without improvement in the feeding of village cattle, little progress will be made in upgrading either draft or milk producing ability. That is why a coordinated programme of mixed farming is so important.

Merely because a bull is raised on a Government farm does not ensure that his offspring will be better than the ordinary run of cattle. There is an urgent need to identify the really outstanding breeding sires among those available on Government farms and then to make as extensive use as possible of the semen of these superior individuals. *To do this, most testing procedures will have to be revised to emphasize the performance of a bull's daughters, instead of his own appearance or even his dam's record.*

There is a need to develop new and higher producing strains or breeds of dairy cattle. This will require more extensive and more systematic cross-breeding programmes than are now being undertaken.

Dairy development schemes should be tied in with cattle improvement programmes wherever possible. This is difficult to accomplish in the milk colonies located near large cities; but even there a concerted effort should be made to breed replacement animals of higher quality than their dams. It may be observed, in this connection, that milk colonies perform an outstanding service by removing animals from cities and providing a dependable supply of quality milk.

Much more emphasis should be placed on improved feeding, breeding, and management of the animals supplying milk to milk processing plants. More cooperative plants collecting village milk directly, at higher prices to producers, and a coordinated, positive cattle development programme are urgently needed.

Poultry Production

Poultry production has a tremendous potential in India. It is strongly recommended, therefore, that steps be taken immediately to encourage expansion of the poultry industry. The following lines for expansion should be exploited: (a) as a village enterprise, (b) as a backyard project for residents of urban areas, and (c) as a commercial business. Here again, the effort in each State should be concentrated on key villages and a limited number of commercial enterprises so that production and market development can be integrated effectively. The immediate objective should be to produce results which will serve to demonstrate the practicability of achieving much higher production.

Poultry excel all other animals in the efficiency with which feed is converted into human food. Other advantages of poultry make them especially useful in India. Among these advantages are: (a) small investment required to get started; (b) their suitability as a family enterprise; (c) small area required, even for large units; and (d) quick financial returns.

Many foodstuffs and by-product materials which either are not suitable as foods for humans or cattle, or are used by them in small quantities, are excellent ingredients for poultry rations. Among such materials which can be utilized by poultry are: blackstrap molasses, penicillin mycelia waste; liver residue, meat offal, fish meal, ground nut oil cake, cow dung; copra meal; fresh blood; rice polishings; wheat and rice bran; dried brewers yeast; kitchen waste; fresh and dried greens; fresh and dried snails; oyster shells; bone meal; tapioca waste; and floor sweepings from flour and feed mills.

Extensive use of food by-products and waste materials would make expansion of the poultry industry possible without competing with humans for scarce and costly cereal grains. The use of considerable quantities of grains for poultry production may be justified, however, when more grains are produced, especially those not commonly used as food by humans.

It is recommended that encouragement, including Government aid if necessary, be given for the production of balanced poultry feeds.

Separate feed mixtures will have to be compounded to meet the requirements of each type of poultry production. For the village poultry enterprise, a simple, supplemental mixture will suffice, since the birds usually will be allowed to range in and about the village, where considerable waste and other materials relished by poultry will be found. On the other hand, birds kept in confinement in and near cities will require more complex mixtures to ensure that all nutrients are supplied in the proper proportions for an adequate diet.

The use of specially constructed cages and batteries for laying hens and young birds should be encouraged and promoted through poultry development programmes. Cognizance should be taken of the fact that external and internal parasites can be controlled and losses from predatory animals eliminated by rearing birds in semi-confinement or confinement. To do this successfully, however, necessitates the use of balanced rations, which will have to be prepared and distributed as described above.

Thus, as the poultry industry develops, increasing attention will have to be given to (a) disease control measures; (b) poultry marketing; (c) larger hatching capacity; (d) educational programmes to encourage poultrymen to purchase day-old chicks; (e) confinement rearing and the feeding of balanced rations; (f) research on nutrition and other poultry problems; and (g) the development of a poultry feed manufacturing industry.

Sheep and Goat Breeding

Continued emphasis should be given to the development of improved strains of both wool and mutton types of sheep. Goat breeding projects should be confined to the milch type. The maintenance of other goats should be discouraged and their place should be taken by

sheep in those areas where it is difficult to keep goats from destroying crops and other vegetation. This problem should be dealt with in accordance with local conditions and situations. In some areas legislation may be justified for preventing the damage done by goats to crops and other vegetation, and for reducing the number of goats. In other areas, where goats supplement milk supplies, a positive plan of goat development should be undertaken.

Pig Breeding

Even though pigs are unlikely to contribute to increased food supplies in the near future, their improvement and development are justified from the long-term aspect of food production.

Evaluation of Progress in Animal Husbandry

There is at present no scientific arrangement for periodically measuring animal husbandry progress. A comprehensive satistical organization for this purpose should be established. This should include elementary training in statistical methods to all workers in animal husbandry.

Alternative Sources of Farm Power

India's bullocks have gained world-wide recognition for their power, speed and endurance. Improved draught breeds of cattle will continue to be the mainstay of farming operations. *Yet pressure on the land is so great that serious study of alternative sources of farm power should be undertaken.* The suitability of small tractors to meet the power needs of different types and sizes of farms should be investigated, both with respect to tillage needs and practices and operating costs.

Applied Research in Animal Husbandry

There is an urgent need for animal husbandry workers to observe and study the practices and procedures used by villagers in the management of farm animals. This should be done with a view of determining whether there are sound reasons for what is being done or whether tradition and ill-founded beliefs are reducing efficiency and blocking progress. *In the opinion of this Team such studies would reveal many opportunities for worthwhile research on simple but important practical problems.* For example, there is widespread belief that to develop into a good bullock, a young bull should not be castrated until he is three or four years old. Satisfactory answers to this question and many others like it will be found only through well-planned and carefully controlled applied research projects.

Animal husbandry workers also need to ask themselves whether the feeding and management practices which they are using on Government farms yield results which have validity under practical farm conditions.

New Sources of Food

It is suggested that India's long-term plans for research on food production include studies of algae, yeast and bacteria as possible additions to present sources of food proteins.

CHAPTER XII—AGRICULTURAL IMPLEMENTS AND MECHANIZATION

Significant increases in food production can be made through the use of improved hand tools, and bullock-drawn implements and some additional mechanical power, including small tractors or power tillers. Gains can be made through properly prepared seed bed, improved placement of seed, better stands, more timely operations and the prevention of losses through harvesting and threshing, in addition to reducing the burden of human effort. These gains will be reflected in greater income to the cultivator and contribute further to India's food supply.

Improved tillage and harvesting practices also become increasingly important if new crop varieties, improved soil fertility treatments, and soil and water management are to yield their full potential increase in yields. Therefore, India has great need and opportunity now and for its future scientific agricultural progress for placing added emphasis on improved agricultural implements and mechanization.

Acceptance of Improved Implements

In a number of areas throughout India one can find impressive examples of the effectiveness of improved implements and mechanization. At the same time, for the masses of cultivators, very little change has occurred. Over the centuries, they have preferred to use those implements whose performance was known and for which they could provide available human or bullock power. And further, since the cultivator depended on the village artisan to make and repair his implements, the artisan's knowledge and understanding has also been a factor in change and improvement.

In recent years many farmers have been using new and improved crop varieties; the demand for commercial fertilizer has increased substantially. Out of these experiences, one might expect that the atmosphere for change would promote adoption of improved implements. However, several problems impede rapid changes. A change in implements usually means that a new skill must be acquired, perhaps several skills. The cultivator not only must understand how to operate the new machine, but the availability of repairs and service complicates his original decision to use new implements. Bringing about change in machines or implements thus requires a more thorough demonstration and training programme, not only for the cultivator but for the artisan involved in manufacture and repairs as well.

It is sometimes said that Indian cultivators do not have sufficient understanding to operate any but very simple machines. Yet the evidence of many farmers successfully using complex tractor equipment, irrigation pumps and other implements, indicates that, with training, they can have sufficient understanding. The successful operation of bicycles is more complicated than many improved farm implements, yet cycles are found in many villages. One can conclude that if the Indian cultivator could understand and appreciate the value of improved implements, he would, with training, have the capacity to operate them successfully. This does not mean that revolutionary changes in equipment should or could be made. A step-by-step process toward mechanization is the sensible and practical approach.

Timeliness of Operations

Successful farmers everywhere recognize the importance of timeliness of operation as related to crop production, i.e., ploughing at the right time, preparing the seed bed under the right moisture conditions, seeding at the right date, harvesting before shattering occurs, and the like. Every farmer is aware of instances when he could have increased yields or prevented losses by more timely operations. Often these instances occur when he is inadequately equipped either with implements, labour, or power.

Moreover, timeliness takes on added importance as the Indian cultivator has opportunity to use new plant protection measures, and chemical fertilizers, and begins irrigating additional land. Improved implements and mechanization will be necessary if the farmer is to take full advantage of each improved practice.

Bullock and Mechanical Power

Since bullock power is universally used throughout India, primary attention has been given in the design of implements to take advantage of bullock power. Even this power is variable. From one part of the country to another, and even from village to village, one can see tremendous differences in the size of the animals, and in breeding and nutrition which reflect in their power delivery. Thus, it is likely that equipment used presently does not now take avantage of the better bullocks; or, in other terms, improved breeding and feeding of bullocks is a factor in providing more power on the farms in India.

Mechanical power is needed in many situations—ploughing, bunding, levelling. This is particularly true for some of the heavier clayey soil. There are some potentially useful soils that are not being used because tractor power is required. Similarly, improved ploughs and other implements are necessary if this land is to be used productively.

Improved Ploughs

Traditionally the Indian cultivator may plough his land 5 to 8 times for certain crops. If improved furrow-turning ploughs were available, he could reduce this to a single ploughing and two cross harrowings. Both time and labour could thus be reduced while preparing a more effective seed bed. Improved bullock-drawn mouldboard ploughs have been successfully demonstrated and distributed in many parts of India. This plough can help the farmer take advantage more successfully of the green manuring practices.

Seeding and Plant Protection

The proper placement of seed is important for germination and in the growth of the crop plants. New methods introduced in India such as line sowing, drilling and dibbling have provided equal or greater yields than traditional methods, and at the same time reduced the amount of seed used. Although substantial progress has been made in sowing methods in certain areas of India, there is tremendous opportunity for demonstrating improved results from this practice.

Effective plant protection from diseases and insects can be achieved only when the specific control measures and necessary equipment

are available. Pesticides are becoming more available. However, there is great need for adaptation, manufacture, and widespread use of dusters and sprayers so that they can become readily available to the cultivator.

Harvesting and Threshing

Delays in harvesting and threshing can cause serious losses for most crops. The hand sickle used in cutting the grain is a slow, labourious and time-consuming tool. Further, reports are made that labour is becoming both scarce and relatively higher priced, at critical periods. The development of more useful hand sickles, cradles and bullock-drawn harvesters would appear to have great possibilities for reducing harvesting losses. The Olpad thresher is an improvement over threshing under bullock feet, and further mechanization into small power threshers would appear to have considerable merit.

Greater adaptation, improvement and use of the wheel in hand tools as well as of power-drawn equipment appear to have considerable merit. Examples might be given of the wheel hoe for weeding, wheel barrow for transporting, etc. Transport carts, improved from the point of construction material and design, offer real possibilities in cost reduction and power requirement per unit of transport.

More Emphasis Needed

Why has there not been more progress in improving India's farm implements? Progress comes from a number of interrelated aspects. First, the improved implement must be identified as being superior. Its value must then be demonstrated to the cultivator. There must be a manufacturer prepared to invest capital to provide not only the machine but the necessary spare parts as well. For this he must be allocated steel. The manufacturer must also develop a sales organization. And finally artisans must be trained who are competent to make repairs for the cultivator. Each link in this chain of activities must operate successfully or the entire programme breaks down.

From the information available to this Team, inadequate attention is now being given in demonstration, production, and training programmes to encourage the use of improved implements. Because of the complex problem, vigorous leadership is needed if improved implements are to make their appropriate contribution to increased food production.

The Indian Council of Agricultural Research, in cooperation with the States, has taken leadership in surveying the indigenous implements which would provide a basis for improvement in their parts of the country. This needs to be continued. Some research has been done by the research institutions, mostly on the design of new implements. Very little work is now being done on the effect of tillage on crop yields under different soil conditions.

The economic feasibility of small tractors and other small mechanical equipment is not known in India. Certainly from the reported successful experiences under Japanese conditions, such small equipment would merit serious study and appraisal.

The shortage of trained agricultural engineers itself contributes to the lack of information and data. It is reported that the Council

of Agricultural Education is currently drafting a syllabus for agricultural colleges in which agricultural engineering would receive greater emphasis.

Leadership is being given by a number of manufacturers of agricultural implements. However, inadequate standards and specifications, and recommendations made without adequate testing, are a factor in delaying acceptance of implements, and/or in disappointing results to the cultivator.

Role of Cooperatives

In a number of areas, cooperatives have taken over the manufacture and repair of hand tools and small implements. As multipurpose cooperatives are formed, they can be extremely useful in furthering the mechanization process among the cultivators. Consideration may be given to cooperative ownership of the more expensive and less frequently used equipment. Making machines available on rental basis for deep ploughing, bunding, land levelling, and other operations would appear to be an important opportunity.

The Agricultural Ministry is now conducting training for village artisans in the design, manufacture and repair of farm implements and hand tools. This programme needs to be intensified.

If India is to take advantage of increased food production through mechanization, substantially increased attention must be given to a number of areas:

(1) Greater recognition and appreciation on the part of administrators and agricultural technicians that improved hand tools, bullock-drawn implements and mechanical power are necessary components of India's agricultural progress.

(2) Intensified activity in identifying, testing, selecting and demonstrating the presently available superior tools and implements.

(3) Training of village blacksmiths and carpenters in the repair and manufacture of improved implements.

(4) Much greater emphasis on research on farm tools, implements and power. This should include studies of the effect of tillage, seeding, harvesting, and threshing equipment on the final crops.

(5) Greater cooperation between many research and extension agencies and organizations, private industry and other groups, is necessary if the full impact and satisfactory progress is to be obtained. Emphasis on such items as standardization of quality, programmes of education and demonstration, and on cultivation equipment, probably would be mutually beneficial, as well as of benefit to the total programme.

(6) Intensified and coordinated training programmes for the maintenance and repair of new and improved implements. Both Government and private industry have responsibilities in this, and should aid in speeding up the mechanization process.

CHAPTER XIII — CHANGING FOOD HABITS

Although most people are reluctant to try new foods, Indian experience indicates that changes are made, either in emergency circumstances, or as a result of income improvement. India has great need for change, both in the quantity and quality of the foods consumed by most Indian families. The quantity of food eaten per person is likely to increase as India's development programme provides employment for more people in urban areas, but nutritional inadequacies may still persist.

Data on consumer expenditures provided by the National Sample Survey indicate substantial increases in expenditures for food as total consumer expenditures increase. Low income groups, whose incomes are likely to increase fastest with economic growth, spend more of this increase on food than do those in higher income groups. This tendency towards higher food consumption is desirable both in the interest of human welfare and as a means of absorbing purchasing power which otherwise might cause inflation. But since at first their greater food purchases consist largely of more cereals, nutritionists report that the diets of the low income groups are very unbalanced, and that they should be improved as rapidly as possible. If urban families experience continued income improvement, however, they tend to buy more of the protective foods, including milk, fruits and vegetables.

We suggest that the increases in total food demand be channelled toward the food which will contribute most to health. People should be strong and capable of doing a full day's work, able to resist disease and to enjoy living. This requires a well-balanced diet.

The following results of a diet survey made during 1945-48 is reported by the Indian Council of Medical Research, New Delhi, 1951. This survey has the disadvantage of a limited sample, but it is the best information available comparing the customary Indian diet with recommended standards.

RECOMMENDED AND ACTUAL FOOD CONSUMPTION

Classes of foodstuffs	Recommended Intake in Ounces	Actual Average Intake in Ounces
Cereals	14.0	16.6
Pulses	3.0	2.3
Leafy vegetables	4.0	0.9
Other vegetables	6.0	4.1
Ghee and vegetable oil	2.0	0.9
Milk and milk products	10.0	3.3
Meat, fish and eggs	4.0	0.9
Fruits and nuts	3.0	0.6
Sugar and jaggery	2.0	0.7
Condiments	..	0.4

The diets of villagers are especially low in protein. Traditional eating habits lead to failure to utilize potential resources of protein-rich food. Currently rice and wheat have a prestige value which is considerably above that of other foods.

Indian nutritionists have experimented with a variety of foods in place of rice. Excellent results in terms of growth and general health

have been obtained from the use of groundnuts for protein, and sweet potatoes and bananas to supplement the cereals. Each of these foods is produced on a commercial scale over large parts of India and yields are relatively high. The problem, therefore, is not a lack of availability or of costs too high for the average consumer, but rather a lack of appreciation of dietary needs.

Vegetables and fruit provide many of the essential elements of a balanced diet. Village fruit and vegetable gardens should be promoted as rapidly as possible. But many problems have to be overcome before they can be an important factor in increasing the quantity and quality of the diet in villages. Some of these problems are:

(1) Suitable sites for gardens with an assured water supply frequently are not available in close proximity to individual family dwellings.

(2) Good seed for a suitable assortment of vegetables frequently is not available, and purchase is considered too expensive.

(3) Information on the culture requirements of fruits and vegetables is not readily available in the villages.

(4) Uncontrolled grazing of livestock is a constant hazard.

(5) Educational material is not available in the village which shows desirable ways to cook, dry, preserve or otherwise utilize fruits and vegetâbles.

Answers to some of the technical problems require experiments on an intensive basis, testing possible approaches to achieving good production in village fruit and vegetable gardens. Such tests should determine sequences of crops, inter-cropping, use of fertilizers and seed needs.

Some of the protective foods can be produced on land which is now unutilized or which is not suitable for commercial crops, such as village common lands. Special arrangements will need to be made for the use of such lands and this may require concurrence by village authorities. Increased milk production can be achieved by the reduction in numbers of useless cattle (as discussed in an earlier chapter), and the utilization for milk production of the feed resources thus saved. It seems quite evident in most locations that if a strong enough demand existed for these foods, the resources could be found for their production. The immediate problem is a lack of knowledge concerning the importance of protective foods in the diet.

A well-conceived educational programme could accelerate changes in food habits. There has been a striking tendency for low income groups to shift from the coarse cereals to rice and wheat with an improvement in their incomes. Nutritionally, this may not be an advance but it demonstrates the possibility of change.

The shortage of food grains in recent years and the widespread necessity for rationing forced many people to substitute one food grain for another, depending upon availability. With the improved supply situation, some have returned to their pre-rationing habits while others have continued in their new ways. Another excellent example of change has been the gradual shift to consumption of coffee in more and more regions outside South India. To some extent this represents a shift from tea to coffee, which shows that old habits can change.

Children are one of the most effective groups to work with in changing food habits. School lunch programmes should be organized throughout the country as rapidly as possible, and every assistance should be given to make them popular. Standard menus, prepared after experimentation, should be made available to insure adequate nutrition. School gardens should be encouraged and the produce from these gardens should be used for the school lunches.

Similarly, factory feeding programmes should be encouraged as a means of improving the diets of workers. Experiences in other countries have demonstrated the value of such programmes in terms of improved health, morale and output of workers.

Per capita minimum requirements for cereals could be reduced appreciably if such protective foods as vegetables, fruits, groundnuts and dairy products were consumed instead. For large masses of the poorer people in India, cereals constitute virtually the only dish. Their food is now prepared in such a way that very small quantities of vegetables are used just for adding some taste. It will be desirable to popularize new menus which aim at making vegetables one of the main dishes. These vegetables and other supplementary foods could be used for improving the low-calorie intake of the lower income people. If a large enough number used such substitutes for food grains, foreign exchange for food imports might be conserved. We would like to emphasize, however, that until adequate supplies of vegetables and other supplementary foods are available and until food habits are changed effectively, the dependence on food grains will continue. It may not be realistic to hope that large changes will take place during the Third Plan.

The technical laboratories in India are conducting many experiments with the preservation of indigenous foods by drying, salting and bringing. Banaras, for example, can be dehydrated for use as a sweet or as a substitute for the fresh product. Increased use of groundnuts is encouraged by new methods of cleaning, crushing or roasting of the nuts. Fruits are preserved in glass jars and tins and sold as a sauce or preserve. India has some of the finest fruits in the world and improved processing methods will permit better use of available supplies. This is especially important for varieties which do not ship well, but which can be used to good advantage if processed and preserved.

As these new processes are perfected, we suggest factories be established in villages having surplus supplies of fruits and vegetables. Local processing can use foods that would otherwise be wasted, especially where a local demand does not exist. This can have the combined effect of economic gain to the village and dietary benefit to the areas where the processed foods are sold.

We suggest a general educational programme to change food habits for better nutrition. The educational material should be channelled through a central agency and disseminated through public health nurses, health workers, agriculture and home science workers, gram sevikas and women SEOs, social welfare workers and teachers. Assistance might be given also by non-governmental organizations such as youth clubs, Red Cross, religious groups and others. The educational material should show clearly the results of inadequate diets and the tangible gains accomplished through improved diets.

It is especially important that such campaigns reach all people. The present buyers of eggs, milk, fish and vegetables are the higher income groups. Supplies of these protective foods are not now sufficient for all of the population, but production should be increased to meet prospective demands. What is needed more immediately is to create a desire on the part of more people to use the protective foods which are available to them.

CHAPTER XIV: PROGRAMME RESEARCH AND EVALUATION

India is putting a tremendous amount of resources, financial, physical and personal, into her many action programmes. Determining the effectiveness of these programmes, and ways to improve them should have high priority. Because of the critical nature of increased food production, top priority should be given to the study of agricultural programmes. Many important decisions must soon be made on new agricultural programmes or major changes in existing programmes. Numerous committees and individuals have recommended major changes in programme content, intensity, methods and structure. But, there is often little concrete evidence upon which to judge the relative merits of proposed changes, or of other important changes required in the future. Hence there is an imperative need for research on carefully designed experimental programmes to determine their effectiveness before they are recommended for more general uniform application.

Later in this report, a number of experimental approaches are suggested. These should be tried out to determine if they could help in increasing food production. However, if they are to provide adequate information for policy decisions, the research that accompanies them must be of high quality. This section deals with some problems in improving programme research and evaluation.

At the beginning of the Community Development Programme India pioneered in setting up a Programme Evaluation Organization (the so-called PEO) independent of programme administration and directly responsible to the Planning Commission. The PEO has produced a number of significant reports. Major policy decisions have been made on the basis of their findings. The Planning Research and Action Institute in Uttar Pradesh has also made significant contributions.

To strengthen research, particularly on food production problems, will require resources, and competent staff from many disciplines. The resources now available in the Programme Evaluation Organization and other research groups should be more sharply focused on evaluating programmes that are directly related to food production. Additional resources may have to be added so that programme research and evaluation can make the contribution of which it is capable.

Staff of research organizations should include competent people from such fields as social-psychology, sociology, cultural anthropology, statistics, economics, political science and public administration. People competent in areas specifically involved in any programme being studied should be included in the research programme. For example, if agronomy, soils and irrigation are parts of the programme being studied, an agronomist and soil specialist, etc., should participate in the research. At the present time the staff of PEO provides top positions for only a limited number of these disciplines and several staff positions are not filled.

Any members of the research programme, whatever their field, must have *research competence.* This assumes that, in addition to knowing their own field, they have some knowledge of statistics, and, equally important, an understanding of rigorous research methodology. For instance, there appears to be only limited use of experimental

design in the research to date. This may partly be because the research workers are brought into the picture only after programmes are well under way. However, more precise measurements would be possible with the use of good experimental designs.

Most studies make only limited use of controls. The setting up of theoretical frameworks, with more precise concept definitions, would make it possible to do more rigorous research. There is always the temptation to collect some data on many things rather than to limit data collection mainly to those things that fit into a conceptual framework where interrelations can be controlled and tested. There could be more use of statistical techniques in the analysis. The generalizing of apparent differences without statistical tests, especially from small samples, is dangerous.

Within this broad context the following recommendations related to programme research and evaluation are made:

1. *There is need for greater concern at all levels for programme research and evaluation especially related to food production.* Specifically, it is recommended that each State explore the possibility of setting up a small programme research unit to work on problems and programmes of special importance to the individual States.

2. *There is need for more precise statements of goals and procedures for the various programmes and sub-phases of programmes.* If programme action people are to determine programme success and if research people are going to measure goal accomplishment more precisely, the goals, both intermediate and long-term, will have to be explicitly stated so that empirical measurement is possible. For instance, to account for the success or failure of the Rabi campaign, certain intermediate goals should be specified, such as cultivator awareness of the campaign, understanding of practices recommended, attitudes toward the practices recommended, practices adopted, as well as the more ultimate goal of increasing food production.

The objectives of some programmes are stated in such general terms that researchers have had to infer more specific objectives for empirical measurements.

3. *The programme research and evaluation people should be brought into the planning process of action programmes at an early stage.* They should not play a major role in planning the programme, unless it is planned that there will be information "feed-back" as the programme develops. However, if they are involved in the planning process, they will have better understanding of the objectives of the programme and of the means being used to attain these objectives. This understanding should enable them to do a better research job.

4. *There should be greater emphasis placed on the study of the attitudinal factors involved in programme planning and execution.* The major objectives of community development are heavily laden with expected changes in the people's attitudes. Of special importance at this time is the understanding of the attitudinal patterns of farm families, that might limit or aid the more rapid adoption of new ideas for increased food production.

What are their aspiration levels, their motivational gaps between their aspirations and performance, their perception of risks, their planning horizons, their attitudes toward change, and "soft spots" in

their attitudinal patterns that may provide openings for change, etc.? Research answers to these questions could certainly aid educational efforts.

Apparently, too, higher nutritional standards could be attained if there were changes in attitudes toward certain foods. The place to begin on this problem is to determine more precisely present attitudes toward selected foods, the basis for these attitudes, and the relation of these attitudes to other attitudes, such as improving dietary standards. It is from this kind of information that a programme to bring about different consumption patterns can more rationally be launched.

The recent study by PEO on the acceptance of selected farming practices and the attitudinal factors related to adoption, satisfaction and dissatisfaction and reversion, begins to explore some aspects of attitudes. However, more precise concepts, tools of measurement and field techniques will have to be used in the future if this important area is to be effectively studied. For instance, scales, indirect methods of questioning and motivational research techniques may have to be used.

5. *There should be increased efforts placed on "process" studies.* There have been some "before" and "after" studies made to measure the change brought about by specific programmes. However, there needs to be more emphasis placed on the *intervening process* of change between the "before" and "after" studies, that is, on what are called "process" studies. Unless a rather intensive study is made of the actual on-going operation of the experimental programme and its efficiency, it is difficult to know just what to try to duplicate when the programme is applied to other areas.

Equally important to the basic philosophy of a programme and its organizational structure are the complex details, human relations and specific procedures that are worked out to make the programme a success. Without the knowledge of these more subtle factors it is difficult, if not impossible, to approach duplication of the pilot programme over a wider area.

Ideally, "process" studies should be made while the programme itself is in process, for instance, with the participant-observer technique. In cases where this is not feasible, many valuable insights can be gained from post-fact reconstruction studies.

The recent studies of the Rabi campaigns in Punjab, Uttar Pradesh and Rajasthan by the PEO are certainly first steps in the direction of process studies.

6. *There should be more effective use made of the case study method.* Case studies are valuable for detailed analysis of a limited number of cases of particular problems, programmes or individuals. There are many examples of outstanding success in India—training centres that are doing an exceptionally good job, different educational techniques that have produced outstanding results, individual villages that have made great advances and individual programmes or workers that have been very successful.

Determing, through case study, the qualities that contribute to these successes should provide much valuable information that could be used in planning future training and action programmes and in making administrative decisions. Many of the case studies made thus

far appear to be more descriptive than analytical. The analytical side of this type of research will have to receive greater emphasis if the studies are to live up to their potential. This means that more precise theoretical frameworks will have to be set up for the essential data needed.

7. *Additional attention should be given to input-output relations.* In a society where resources are scarce, the resources should obviously be allocated to produce the most efficient results. A study of alternative organizational, administrative, content, and method approaches should be set up. Thus the relative amount of inputs that produce outputs can be measured. An attempt should be made not only to measure the quantity of inputs but the quality. This is especially important in the case of human resources. One of India's problems when it attempts to extend a successful pilot project over larger areas is how it can duplicate the quality of inputs that originally brought successful results. The quality and quantity of inputs, including the very important input of human resources, needs to be known when deciding to extend pilot projects to a wider area. This is not to say that the basic ideas of a pilot project should not be expanded if the same kinds of resources are not available. However, a knowledge of input factors should enable the planner to make more rational decisions about the quality and quantity of personnel and other resources needed for acceptable performance and have more realistic expectations in terms of results. Thus, studying the programme in process, as well as its "before" and "after" results, becomes especially important.

8. *Research and action people should be aware of the problem of "feedback" in experimental research.* In some cases it may be desirable to "feed" research data gathered in an ongoing programme to the action people as a basis for making decisions as the programme progresses. It is important to recognize that if this is done the research worker and data become a part of the experiment. Thus, caution should be used in generalizing the results attained to other situations where research will not be a part of the programme and where data similar to that gathered by the research worker will not be available for making planning decisions.

9. *There should be a clear understanding of the role of "ideal" experiments.* The term "ideal" is used in the sense of carrying out a project with all of the needed resources under the best possible conditions. From the point of view of using an experiment as a demonstration of what can be done, there is a logical place for the "ideal" experiment. However, caution must be exercised in attempting to apply the findings to other areas without carefully thinking through the limitations, the changes that need be made and the probable success under less "ideal" conditions. This caution is often not exercised.

10. *There is need for more research on administrative structure.* There seems to be general agreement that the major problems in India lie not so much in basic idea or philosophy of the programmes but in implementation. If this is true, there is need for an analysis of basic administrative structure and administrative policies and procedures through which programmes are implemented. Though some beginning studies have been made of the job of the VLW and other officers, there has been little done that could be called an intensive analysis of the roles of any specific worker.

Equally important is the study of the interrelation of roles and communication patterns at a given level, for example the block officers or district officers. Also of importance is the study of vertical relationships. An intensive study of the vertical relations among the VLWs and block agricultural officer, the district agricultural officer, etc., should give answers to many problems of programme administration, communication and motivation.

Studying the flow of specific directives and action programmes through the structure should also be significant. Of special importance at this time would be a study of the relation of extension, teaching and research, and of the possibilities of integrating these three functions to make the greatest impact on food production.

11. *Programme research and evaluation groups have the opportunity to make a contribution to the basic theory of human motivation, social action and programme planning and execution.* If more precise theoretical models, concepts, tools of measurement and analyses are used, such research projects can test many hypotheses and develop a body of principles and theory of great aid in planning and executing future programmes. It is belived that the Extension Wings of the agricultural colleges should be staffed and budgeted so that they, in cooperation with other relevant staff members, could make a major contribution to such research.

CHAPTER XV: EXPERIMENTAL PROJECTS ON INCREASING FOOD PRODUCTION

If India is to meet the challenge of increased food production, major changes will have to be made in existing programmes and new experimental methods will have to be worked out. She has sufficient experience with certain types of programmes. But before some of the other major programme changes are made, *it is important that carefully designed experimental programmes be set up to test the probable effectiveness of the changes.* Such experimental programmes, when accompanied by adequate data gathering and analysis, can provide a sounder basis for making policy decisions.

There are a number of such experimental projects that should be undertaken as soon as possible. The Team recommends that the following three projects be given a high priority:

1. *Experimental projects to determine realistic food production potentials of Indian villages under optimum field conditions.*
2. *Experimental projects to determine the value of trained farm management assistance in helping cultivators increase food production and income.*
3. *Experimental projects to measure the effectiveness of the intensified use of mass media and visual aids as a part of an increased food production educational effort.*

1. An Intensified Programme to Determine Realistic Food Production Potentials.

The need for more trained agricultural officers working as closely as possible with the cultivators has been pointed out earlier in this report. Specific recommendations have been made about the placing of these officers as soon as they are available. However, as India looks to future decisions on the most effective agricultural staffing pattern, there is need for experiments to determine how much technical help and other assistance is necessary to achieve realistic increases in food production. How much could food production be increased in a group of villages if the cultivators were given adequate educational and technical assistance, if needed resources such as fertilizer, seed and pesticides were made available to them, and if they were given assistance in organizing credit, marketing and supply cooperatives?

An experimental programme carried out to determine what that potential is under field conditions should provide valuable data upon which to base future decisions regarding needs for financial and technical aid, trained personnel and the most effective staffing patterns.

We suggest that each State undertake such an experiment with a core staff of three people serving *approximately* five contiguous villages. The productive potential of the villages selected should be moderately high. The staff should be made up of college graduates with extension field experience. One staff member should be a farm management specialist. The other two staff members should be chosen on the basis of the most important needs of the experimental area. For example, a specialist in water utilization might be assigned full time if production could be increased significantly by improving water management.

The five-village area is suggested because it is believed that a staff of three could adequately serve that large an area. Moreover, in most cases the five villages would provide opportunity for efficient cooperative activities in credit, farm supplies, marketing and local processing. If it were found that a larger number of villages were needed to provide some of these credit and other services efficiently, more than five villages could be used in the experimental unit for these specific services, adding additional staff resources, if needed, to handle the services.

In these experimental projects, the core staff should have at their disposal, as needed, trained specialists from other fields, such as agronomy, credit, plant protection, animal husbandry, agricultural engineering, marketing and processing, home science, sociology and extension education.

One of the first major steps that should be taken is to record and analyze existing conditions and plan changes that might be made to increase food production economically. The use of photographic as well as statistical records is valuable in this connection. Such an analysis would include the *possibility of improvements in:*

(1) Water management, such as the development of good conveyance structures, land preparation for good water distribution, the application of water at the proper time and the correct amount for various crops and soils. On non-irrigated areas it would include such practices as contour bundings, levelling and terracing; also development of new sources of water.

(2) The use of fertilizer—the kinds and amounts needed, and the time and method of application for different soils and different crops.

(3) Cropping patterns—the most suitable crops for the area, proper crop sequence and the possibilities for multiple cropping.

(4) The use of seeds—the best improved seeds of the highest yielding varieties for the various crops.

(5) Pest control.

(6) Mixed farming and integrating livestock production into farm plans such as dairy, piggery, poultry and bee-keeping.

(7) The use of credit—the amount and type needed and most effective way of extending credit.

(8) Efficient securing of adequate supplies and the marketing of farm products.

(9) Supplementing family diets by growing vegetables and fruits.

(10) Economical use of agricultural implements and mechanical power.

(11) Farm management plans, using the best combinations of all of the above factors for increased food production and income.

(12) Institutional and organizational structures, including cooperatives, through which the needed changes could be brought about.

To the extent of their ability, villagers should be involved in this analysis. The analysis would probably reveal many conditions

that can be improved only through cooperative group effort, for example farm consolidation, irrigation projects, cooperative credit, supplies, marketing and institutional changes.

Out of this analysis there should be developed, with the villagers, a realistic step-by-step programme leading toward their economic production potential. The details of such a programme cannot be spelled out in this report. However, certain considerations can be mentioned as illustrations.

It is not unrealistic to think of individual farm plans being prepared for all cultivators under the guidance of the farm management assistant. Cooperative societies would have to be formed or strengthened to provide efficiently such services as credit, supplies and marketing. An experiment could be tried giving much greater local control over cooperative activities, hiring of a highly capable manager, and providing adequate godown-storage conveniently available to each village, with a larger godown centrally located, for instance, in a mandi centre. The possibility of initiating a village scheme for vegetable production to supplement the diets of the villagers should be explored. Experimental approaches with the objective of improving food habits should be tried.

The villagers should be asked to make their own estimates on how close they could come to meeting their food production potential. If they establish a target high enough, a bonus might be offered to the village for attaining the agreed-upon target.

The programme should be carried out by the villagers under the direction of the core staff. Such a programme should have optimum resources at its disposal. There would need to be skilled people in extension education. Technical specialists, in addition to the core staff, should be available as needed to help carry out the programme.

For instance, if farm consolidation is undertaken, a competent technical specialist should be made available to analyze the situation and help carry out the programme for maximum use of land and water resources. Specialists on irrigation and drainage should work with the core staff and villagers in planning and carrying out the needed programmes. During the growing seasons constant supervision by competent experts should be maintained to provide a means of diagnosing any threats to high yields such as insects, disease, lack of nutrients or water.

An appropriate part of the experiment could be the development of one of the villages as the "seed multiplication village." This selected village should serve as the primary source of Certified seed for the other villages in the group. This scheme could apply equally well to all kinds of food-grains including hybrid maize. (Additional organizational and operational details are given in the earlier chapter on seed multiplication.)

Needed resources such as credit, irrigation facilities, fertilizer, seed, insecticides and equipment should be made available to the project. Existing procedures and regulations should be changed if necessary to facilitate carrying out the programme.

Because of the need for major changes, and the experimental nature of the project, an agreement should be reached with the cultivators to guarantee them against losses resulting from adoption of the

new ways of farming. If a realistic programme is developed, the cultivators should have appreciable gains in income rather than losses.

If these projects are to provide the data upon which to make such decisions, they must be accompanied by adequate data gathering and analysis. Benchmarks should be taken before the experiments begin, in order to measure such things as the level of production in the villages, the attitudes of the people and the practices being used. The experiment must be studied in process to determine the important ingredients necessary to programme success and their relationships to each other. The personnel inputs in terms of quality and quantity must be determined. The amount of change brought about by the experiment, including increased food production, must be determined.*

This type of experiment, accompanied by adequate research, should provide valuable information on the amount and kinds of technical help needed by the cultivators to achieve realistic increases in food production. An analysis of the financial and physical resources needed and the type and number of people that must be trained should provide valuable guides to rational decisions about the efficiency of such programmes and the practicability of duplicating or modifying them for general application over a wider area.

2. **Experimental Programme Involving Farm Management Assistance to Cultivators.**

Many cultivators consistently obtain higher yields of crops and higher incomes than their neighbours even though their farms are no larger and their basic soil, water and other resources are no better than the average for the village.

These cultivators combine better tillage and irrigation, good seed, chemical fertilizer, pest control and other practices that are necessary for high crop yields. They practise double cropping and they grow the crops that bring them the highest return. They also feed their livestock better; consequently the bullocks do more work, and their cows and buffaloes give more milk. In other words, they have learned the art of better management. Unfortunately such cultivators are the exception rather than the rule.

Experimental programmes, therefore, should be developed to ascertain whether many more farmers in the villages can be induced to adopt improved and more profitable systems of farming. Specifically it is suggested that the value of trained farm management assistance to cultivators should be tested as one experimental programme in each State.

Trained farm management assistance is an integral part of Experiment 1 suggested above. However, such assistance is believed to have such a great potential in itself that it should be tested in separate experimental projects. If it proves successful, it could be applied in additional areas as rapidly as managers can be trained.

Such a programme should: (1) Provide a field laboratory for working out a realistic approach to farm management assistance in India; (2) Demonstrate the value of good farm management assistance to farmers, and to Centre and State officials; and (3) Provide valuable

* A more detailed discussion of research methodology appears in the preceding chapter.

data for making recommendations to cultivators who are operating under similar soil, climatic and other conditions.

The experiment might proceed as follows. A person would be employed who had practical village experience and aptitude for and training in farm management. His main programme would not be executed through the VLW, but he would have the task of working directly with cultivators on the best ways of combining improved practices and new crops for increased production and income. The VLW could play an important supplementary role in such ways as helping choose which farmers to work with and helping, to the extent of his ability, in some of the direct practice teaching. The farm management specialist would work in a group of not more than 5 villages. He would begin by working with a few cultivators in each village. Small, medium and large farms should be represented.

The resources on each farm would be analyzed and a simple budget would be prepared to show the income that can be expected if the farm continues to be operated on present lines. Then a simple alternative budget would be prepared which would include the combinations of crops and of improved practices that seem best adapted to farms in that area. Livestock operations also would be considered. The prospective income from the alternative plan would be calculated, and if there was clear evidence of potential income improvement, an attempt would be made to persuade the cultivator to adopt the alternative plan or a modification of it.

A competent management assistant would not stop at this point, however. He would work with soil and water conservationists and other specialists to provide technical assistance in the adoption of new techniques. He would help the cultivator obtain needed resources such as fertilizer, improved seed, pesticides and machinery. In an experimental project, these resources should be available to the cultivator in adequate quantities, and credit should be supplied as needed to undertake the new farming system.

It should be recognized that the new plan might require additional credit, and, in the mind of the farmer, greater risks. Therefore, at the beginning of such a programme, it might be necessary to guarantee the cultivator against loss from undertaking the new farming plan.

After experience has been gained with plans for the first group of cultivators, simpler plans could be worked out for other villagers who are interested. As experience is gained, and if the results of farm planning are successful, most of the cultivators in a village might be attracted to the offer of management assistance.

The management assistant could function as a member of the loan committee for the local credit society. In this way loans would be facilitated for those who undertook improved farming programmes, and the credit society in turn would be assured of some supervision of the loans based on the farm plans. The management assistant also would make economic evaluations of plans for soil and water conservation, and of all demonstrations to be undertaken in the experimental villages.

If a management assistant were assigned to 5 villages, he might develop a clientele of about 100 cultivators in the first year. Many more

cases could be handled on a less intensive basis as the idea of management assistance spreads, and as the worker gains more experience. Perhaps in the second, or at least in the third year, an entire village would agree to accept management assistance to achieve a food production target that seemed feasible to them after the increase potentials had been demonstrated. In this event, consideration might be given to the Government's entering into a contract with the village to pay a bonus for achievement of the target set. The bonus might be used for village improvement.

Trained personnel for management assistance would not be available at the beginning of such a programme. An intensive training school should, therefore, be arranged for a three-month period. The best farm management specialist obtainable would teach, by means of actual field experience, specific techniques in planning farms and advising cultivators concerning possible improvements in their operations.

The candidates selected for this type of training would need to be college graduates with village backgrounds, and with some professional experience in working with cultivators.

An experimental programme of this type should be closely associated with an agricultural college. The farm management staff at the college might undertake responsibility for general supervision of the programme. Those who are teaching agricultural economics would then have an opportunity to become better acquainted with actual village problems.

3. Experimental Programmes on the Intensified Use of Mass Media in Supporting Educational Programmes.

This report has elsewhere urged intensification of the use of mass media in supporting food production programmes. It has been pointed out that mass media serve as an excellent device for making people aware of new ideas and encouraging them to adopt new ideas. To date, there has been only limited use of mass media in most States. This is partly to be expected in India because of the low literacy rate and the lack of availability of newspapers and radios in many villages. However, even with these limitations, it is believed that the effective use of mass media can improve the educational efforts and strengthen the agricultural programmes with relatively low costs for results obtained. It should be emphasized that to secure the greatest returns, the use of mass media must be an integral part of a more general educational effort.

It is recommended that the intensified use of mass media be tried on an experimental basis in an area such as a 'taluka' or district in each State. A similar area should be selected for control. To make it possible to obtain the greatest impact, a radio should be provided to each village and newspapers to literate villagers. Other printed and visual materials should be prepared.

As the programme is planned, the mass media should support the educational effort. The radio should make people aware of the food production programme, enthuse them about it and provide specific information needed about improved practices. Appropriate radio programmes and materials should be developed and used to make the greatest impact.

An analysis of the educational programme on food production should point out the kinds of films, film strips and slides that might be used at the various stages to improve teaching effectiveness. The contributions that pamphlets, leaflets, posters, wall newspapers, flip charts and manuals and guides could play should be investigated and appropriate materials prepared.

A much more intensive use could be made of newspapers by preparing news releases, obtaining local coverage on the programme and printing interviews and success stories obtained from local farmers. Prior planning so that these various mass media could be logically fitted into the flow of the educational programme is of great importance. If effective use is to be made of these media there may be the need for additional training for the professional workers involved.

By using mass media to support an educational programme, the effectiveness of the programme could be greatly improved. The experiment proposed should help give valuable data on the most effective way of using mass communication in this supporting role.

APPENDIX

BIOGRAPHICAL NOTES

U.S. MEMBERS OF THE TEAM ON AGRICULTURAL PRODUCTION

Dr. MARVIN ANDERSON, Associate Director of Extension, Iowa State College, Ames, Iowa.

Dr. Anderson is one of the best known administrators in the field of cooperative extension work in agriculture and home economics in the U.S.A. With an undergraduate major in agronomy, graduate specialization in soil management and later in agricultural economics, Dr. Anderson has held various positions in the extension service since 1939, including county, district and state extension assignments. His national leadership in extension work has included service as an adviser on Rural Health to the American Medical Association, Chairman of the North Central Regional Committee of Extension Directors, and Member of the National Extension Committee on Extension Organization and Policy. He is the author of several publications and articles dealing with problems of soil building, soil conservation and extension methods that promote improved agricultural practices. Dr. Anderson served the Team in India as vice-chairman and as an authority on extension organization and extension educational methods.

Dr. GEORGE M. BEAL, Professor of Sociology, Iowa State College, Ames, Iowa.

Dr. Beal served the Team as a specialist in extension organization, and extension educational methods. With post-graduate specialization in agricultural economics and rural sociology, Dr. Beal is the author or co-author of more than 40 publications, many of which deal with research in the communication of information on new agricultural practices. Dr. Beal's studies of how knowledge is diffused among farm people are internationally known, and he has had wide experience as a consultant in this field.

Dr. E. M. CRALLEY, Professor and Head, Department of Plant Pathology, University of Arkansas, Fayetteville, Arkansas.

Dr. Cralley received the Ph.D. degree in plant physiology and plant pathology from the University of Wisconsin. Having served previously as a consultant in Panama, Cuba and Korea, Dr. Cralley is oriented to the understanding of foreign agricultural problems, and is especially well known for his work in plant disease control. He has made a special study of the work on rice production in Japan. A year ago he served as adviser to a large concern in Cuba as a specialist in rice production. As a member of the Team in India, he has concentrated on problems of cereal and rice production.

Mr. GERALD HUFFMAN, Assistant Administrator, Federal Extension Service, U.S. Department of Agriculture, Washington, D.C.

Mr. Huffman is presently responsible for U.S. extension programmes at the national level. He has had post-graduate study at Harvard University where he specialized in public administration. Before undertaking administrative responsibilities, he had served as an extension specialist, a food and agriculture adviser in Europe and as a field representative for the Federal Extension Service. In India, Mr. Huffman served the Team as a specialist in extension organization and extension educational methods.

Dr. OMER J. KELLEY, Chief, Western Soil and Water Management Research Branch, U.S. Department of Agriculture, Fort Collins, Colorado.

Prior to undertaking his present position in Colorado, Dr. Kelley was in charge of irrigation research in the 17 Western States of the U.S.A. He is a former Chairman of the Western Soil Science Society of America and a former Chairman of the Western Branch of the American Society of Agronomy. He is a member of the International Commission of Irrigation and Drainage, serves on the U.S. executive committee of the Commission, and is a member of the International Society of Soil Science. He has served the Team as a specialist in water utilization.

Dr. CHARLES E. KELLOGG, Assistant Administrator for Soil Survey, Soil Conservation Service, U.S. Department of Agriculture, Washington, D.C.

Dr. Kellogg is one of the most widely known authorities in soil science and soil conservation. In 1950 he was awarded a gold medal by the U.S. Department of Agriculture for distinguished service to agriculture. He is the author of numerous research reports, books, and bulletins. Dr. Kellogg has taken an official part in the congresses of the International Society of Soil Science and many other international conferences on science and agriculture. He has participated in the work of the International Institute of Agriculture in Rome, and was Secretary of the Agriculture Committee at the organization meeting of F.A.O., Quebec, 1945. He was a guest scientist of the U.S.S.R. Academy of Sciences in 1945, and has been a guest scientist in the Belgian Congo, the United Kingdom, New Zealand, Australia, Iceland, Israel, France, Ghana, India and various other countries. He headed a U.S. study group on soil and water use in the U.S.S.R. in 1958. His report of 1958 on *Soil Conservation and Soil Survey in India* was published by the Ministry of Food and Agriculture in 1959. Dr. Kellogg served the Team as a specialist in soil science and in soil and water conservation.

Prof. ALVIN A. JOHNSON, Professor of Plant Breeding, Cornell University, Ithaca, New York.

Professor Johnson is widely known for his work in seed marketing research and in the multiplication and distribution of improved seeds. He is author of many technical and semi-technical

articles and publications on seed problems. He is a director of the International Crop Association and a member of the Planning Conference of the National Foundation Seed Project. Professor Johnson has served as a seed production specialist with the American Mission for Aid to Greece in 1948 and as a professor in extension and seed production at the University of Salonica. He was also a consultant to the Greek Plant Breeding and Seed Multiplication Programme. He has also studied improved seed programmes in other Near Eastern and European countries. He served the Team as a specialist in seed multiplication and distribution.

Dr. SHERMAN E. JOHNSON, Chief Economist, Agricultural Research Service, U.S. Department of Agriculture, Washington, D.C.

Dr. Johnson visited India in 1958 when he was elected President of the International Conference of Agricultural Economists at the Mysore meeting of the Conference. After receiving the Ph.D. degree in Economics from Harvard University, Dr. Johnson served in teaching and research in each of the major agricultural regions of the United States, and has been on the staff of the United States Department of Agriculture for the past 25 years. During World War II he was Director of Food Production in the War Food Administration. He received a citation for distinguished service in the U.S. Department of Agriculture in 1958, and is a former president of the American Farm Economics Association. Although broadly trained and experienced in agricultural economics, Dr. Johnson is known especially as an expert in farm management, which field he represented on the Team. Dr. Johnson served also as Chairman of the Team.

Mr. HAROLD A. MILES, Deputy Governor, Farm Credit Administration, and Director of the Short-Term Credit Service of Farm Credit Administration, Washington, D.C.

Mr. Miles served as a county agricultural extension agent, as a supervisor in agricultural extension work, and as a farm management specialist. He did graduate work in agricultural economics and served as a State Representative of the Bureau of Agricultural Economics of the U.S. Department of Agriculture. He later became Secretary and then Vice-President of the Production Credit Corporation of Wichita, Kansas, which had responsibility for supervising the Agricultural Production Credit Associations in Kansas, Oklahoma, Colorado and New Mexico. Mr. Miles served the Team in India as a specialist on cooperatives and agricultural production credit.

Miss ELLEN L. MOLINE, Adviser in Home Economics, Ford Foundation, New Delhi, India.

Miss Moline has been in India with the Ford Foundation for four years and has been working in the fields of home economics extension and nutrition. She served the Team as a specialist in these fields. Starting her professional career as a school teacher, both in rural and urban schools, Miss Moline has had

the experiences of volunteer 4-H Leader, 4-H County Leader, and County Home Demonstration Agent. She has the degrees of B.Sc. in Home Economics Education from the University of Minnesota and M.A. in Adult Education and Extension, Columbia University. Outside the continental United States, Miss Moline has served as a home economics and extension adviser in Hawaii and Nepal, as well as in India.

Mr. FRANK K. NAEGELY, G. L. F. Exchange, Ithaca, New York.

Mr. Naegely is a specialist in cooperative organization. Originally trained in animal husbandry and agronomy, Mr. Naegely has served as a dairy specialist and has had long practical experience as manager of cooperative stores and as a director of service stores for the Grange League Federation, which is one of the most widely known agricultural cooperatives in the United States. Mr. Naegely served the Team in the field of organization and operation of supply cooperatives.

Dr. ARTHUR D. WEBER, Dean of Agriculture, Kansas State University, Manhattan, Kansas.

Dr. Weber is in charge of research, resident teaching and extension work in agriculture at Kansas State University. He was first associated with that institution as a specialist in animal husbandry. Dean Weber is a specialist in animal nutrition and in animal breeding, as well as being an experienced administrator, having served once as acting President of Kansas State University. He was granted an honorary degree of Doctor of Science by Purdue University in 1950, only 10 years after earning his Ph.D. there. Outside the United States, Dean Weber has had professional experience in England, Canada and South America. He has visited India previously, as a consultant in agricutural administration and livestock development. He served the Team especially as an expert in problems of animal husbandry and livestock development.

Dr. NORMAN WENGERT, Professor of Government, University of Maryland, College Park, Maryland.

Dr. Wengert has served as Chairman of the Social Science Department at North Dakota State College. He has also been a member of the Programme Staff in the Office of the Secretary, U.S. Department of the Interior, and he has held various positions with the Tennessee Valley Authority, dealing with agricultural and resources administration. He has been a Research Associate with Resources for the Future, Inc., an American research foundation. Professor Wengert holds an LL.B. and a Ph.D. from the University of Wisconsin where he specialized in political science and public administration. He is the author of two widely known books: *Natural Resources and the Political Struggle* and *Valley of Tomorrow: TVA & Agriculture*. In India, Dr. Wengert served the Team as Secretary, and as a specialist in agricultural organization and administration.

INDIAN ASSOCIATES OF THE AGRICULTURAL PRODUCTION TEAM

Dr. J. K. **BASU**, Director, Soil Conservation Board, Government of India, New Delhi.

Mr. M. P. **BHARGAV**, Cooperation Commissioner, Government of India, New Delhi.

Dr. R. **DEVADAS**, Chief Home Economist, Extension Wing, Ministry of Food and Agriculture, Government of India, New Delhi.

Mr. K. P. R. **KARTHA**, Livestock Specialist, Extension Wing, Ministry of Food and Agriculture, Government of India, New Delhi.

Mr. P. D. **NAIR**, Additional Director of Agriculture (Retired), New Delhi.

Mr. J. V. A. **NEHEMIAH**, Extension Commissioner, Ministry of Food and Agriculture, Government of India, New Delhi.

Dr. T. R. **MEHTA**, Director, Farm Advisory Service, Extension Wing, Ministry of Food and Agriculture, Government of India, New Delhi.

Dr. J. S. **PATEL**, Agricultural Adviser, Ministry of Community Development, Government of India, New Delhi.

Dr. K. **RAMIAH**, Rice Specialist, Retired.

Mr. **AMIR RAZA**, Joint Secretary, Planning Commission, King Edward Road, New Delhi.

Dr. S. R. **SEN**, Joint Secretary, Planning Commission, King Edward Road New Delhi.

Dr. **ARJAN SINGH**, Director of Agriculture, Chandigarh, Punjab.

SPECIAL ASSISTANTS

The following individuals were intimately associated with the work of the Team and rendered especially valuable assistance to it.

Dr. *HOWARD W. BEERS*, Consultant in Rural Development, The Ford Foundation, New Delhi. Dr. Beers served the Team in a liaison capacity and contributed materially to the consideration of problems of extension organization and administration.

Miss *JEAN JOYCE*, Executive Associate, The Ford Foundation, New Delhi. Miss Joyce served the Team as general editor of the report.

Dr. *JOHN G. McNEELY*, Professor of Agricultural Economics, Texas A. & M. College, U.S.A., and presently visiting Ford Foundation Professor in Social Science Research, Gokhale Institute of Politics and Economics, Poona. Dr. McNeely worked with the Team on economic problems and contributed materially to the chapters on marketing and economic intelligence.